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OBSERVATIONS CONCERNING A WINTERING POPULATION OF BALD EAGLES ON AN AREA IN SOUTHEASTERN NEW YORK[1]

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ABSTRACT

A wintering population of 20 to 25 bald eagles, perhaps the largest single concentration in the Northeast, was studied on an area in southeastern New York consisting of a series of reservoirs used for the generation of hydroelectric power. Observations on habitat use, daily activity, prey and feeding behavior, and intra- as well as interspecific interaction of the eagles were recorded. Ice-free feeding areas and injured fish, resulting from operation of the power-generating facilities, were the prime factors in attracting the eagles to this site. Continued operation of the facilities is considered essential to maintaining these conditions. Proposed developments on the wintering area that might affect the eagles adversely, as well as economic pressures that might have a significant impact on this population of wintering eagles, are discussed.

Mounting concern for the bald eagle *(Haliaeetus leucocephalus)* by numerous conservation organizations and government agencies in recent years has prompted studies of its nesting habits (Herrick, 1924a, 1924b, 1924c, 1932, 1933; Murie, 1940; Broley, 1947; Hensel and Troyer, 1964; Troyer and Hensel, 1965; Mathisen, 1968; Grier, 1969; Retfalvi, 1970; Sprunt et al., 1973; Dunstan and Harper, 1975) and its relationships to environmental contaminants (Coon et al., 1970; Reichel et al., 1969; Krantz et al., 1970; Mulhern et al., 1970; Belisle et al., 1972; Grier, 1974; Cromartie et al., 1975). Although little has been published regarding the biology of bald eagles on their wintering grounds, existing literature in-

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cludes the identification of a roosting area in Utah (Swisher, 1964), a census of wintering eagles on the Gulf Islands of British Columbia (Hancock, 1964), observations of autumn concentrations in northwestern Montana (McClelland, 1973), a report on aspects of the biology of bald eagles wintering on the Mississippi River near Savanna, Illinois (Southern, 1963, 1964) and a study to determine activity patterns and habitat requirements of a wintering population in Idaho (Lint, 1975).

The ecological relationships of bald eagles to their traditional wintering areas are just as important as their relationships to nesting areas. Wintering areas provide food and open water largely unavailable at that season in other areas (e.g., nesting areas), and known concentrations range from nine to 250 birds (Spencer, 1976). Toxicant levels in winter foods on these areas are of special significance since these foods are the ones that the eagles feed on prior to the nesting season and that may directly affect the viability of the eggs produced. The fact that a relatively few wintering sites of relatively small size (considering the density of the winter population) support such large numbers of eagles, and that chemical pollutants on these sites may affect nesting success over a large area, makes the protection and enhancement of wintering areas critical to the continued survival of the species. A number of sanctuaries have been established to protect feeding and roosting sites of wintering bald eagles (Table 1), but they are all located in the Midwest or West.

TABLE 1. SANCTUARIES ESTABLISHED FOR THE PROTECTION OF WINTERING BALD EAGLES AND THEIR HABITATS*

Name and location	Year established	Sponsoring organization	Size (hectares)	Eagles using area
Cedar Glen (Iowa)	1970	Illinois Nature Conservancy	171	60-100
Eagle Valley (Wisconsin)	1971	Eagle Valley Environmentalists	560	§
Carl Mundt Natl. Wildl. Ref (South Dakota)	1974	National Wildlife Federation	454	136
Ferry Bluff (Wisconsin)	1976	National Wildlife Federation	61	26
Skagit River (Washington)	1976	Nature Conservancy	212	148

*From Spencer (1976):131-134.
§Not given.

Bald eagles have been, and are presently, known to winter in some areas of the Northeast. According to Spencer (1976), up to 65 birds may winter scattered along the Maine-New Brunswick coast, and an average of 10 have been observed wintering on the Quabbin Reservoir in Massa-

chusetts in recent years. Through the 1880's and into the early 1900's, wintering groups were often seen in New York State where open water persisted. Large numbers once spent the winter along the Hudson River and on Long Island (Mearns, 1878; Bent, 1937; Spofford, 1953). During one winter in the mid-1800's, 60 to 70 bald eagles were shot on Long Island (Giraud, 1844). An area in Sullivan County (N.Y.) presently (1977) supports what may be the largest single winter concentration of bald eagles in the northeastern United States. This paper is an interim report on a long-term study to determine the population status and ecological relationships of bald eagles on this area, as well as their migration routes and summering grounds, as a basis for management plans designed to protect and enhance the area for this species.

STUDY AREA

The study area of approximately 75 square kilometers is located some 12 kilometers southwest of Monticello in Sullivan County in southeastern New York. The prinicipal wintering area consists of a series of three reservoirs along the lower Mongaup River and five other reservoirs and lakes associated with this system (Figure 1). County Road 43 bisects the area and provided access to the northern end of Mongaup Falls Reservoir. A town road provided access to the eastern side of Rio Reservoir, and a private road followed the Mongaup River between Swinging Bridge and Mongaup Falls Reservoirs. Other private roads led to the other water bodies of interest in the area. The Mongaup River has its source near Liberty (N.Y.), flows south 64 kilometers to the Delaware River and drains a watershed of 54,400 hectares. The river flows through an area of rolling terrain with steep slopes. The forest growth was characterized by beech *(Fagus grandifolia)*, sugar maple *(Acer saccharum)*, hemlock *(Tsuga canadensis)*, yellow birch *(Betula alleghaniensis)*, white birch *(Betula papyrifera)*, balsam fir *(Abies balsamea)*, red oak (*Quercus rubra)*, white oak *(Quercus alba)* and white pine *(Pinus strobus)*.

The land adjoining 30 per cent of the river and main reservoir system in the study area consists of Catskill stony loam which is suitable for forestry practices (Secor et al., 1948), and the terrain is rolling. The remaining 70 per cent consists of poorer soil material and is characterized as either rough mountainous land or rough stony land. The poor soil, together with the steep slopes, rockiness and poor drainage, make these parts of the area unsuitable for forestry. Elevations range between 244 and 434 meters.

According to Mordoff (1949), the area receives an average annual precipitation of 114.3 centimeters, while snowfall averages 134.6 centimeters. For the period from November through March, the mean tem-

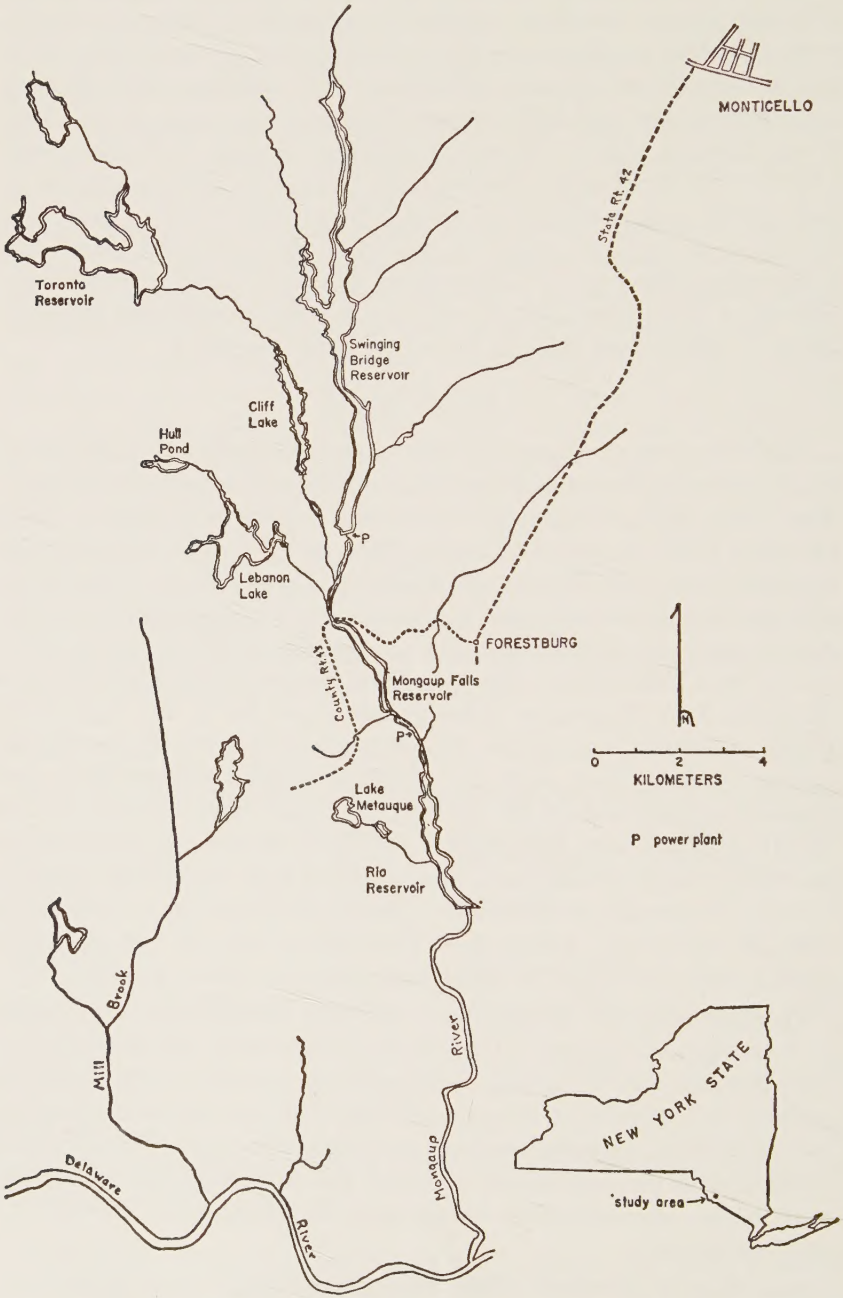

Figure 1. Map of bald eagle study area in Sullivan County (N.Y.).

perature is −3.1° C., with the average maximum and minimum being 1.6° C. and −8.0° C., respectively. The average date of the first frost is October 3.

Rio, Mongaup Falls and Swing Bridge Reservoirs were constructed by the Orange and Rockland Utilities Corporation and its predecessors on the lower half of the Mongaup River in the 1920's and 1930's for the generation of hydroelectric power (Table 2). Other reservoirs and lakes

TABLE 2. PHYSICAL CHARACTERISTICS OF WATER BODIES ON THE BALD EAGLE WINTERING AREA IN SULLIVAN COUNTY, NEW YORK

Water body	Date built	Elevation (meters)	Area (hectares)	Depth (meters)		Shoreline (kilometers)
				Maximum	Average	
Hull Pond	*	352.0	21.8	4.2	1.5	2.4
Lake Metauque	*	387.1	28.5	*	*	2.2
Lebanon Lake	*	346.6	108.9	2.1	*	8.1
Mongaup Falls Reservoir	1923	285.0	48.6	13.7	5.5	9.3
Toronto Reservoir	1926	371.9	348.0	24.4	10.1	18.2
Rio Reservoir	1927	248.1	186.2	29.0	11.6	15.0
Swinging Bridge Reservoir	1930	326.1	404.7	36.6	13.7	27.7
Cliff Lake	1939	326.7	76.9	12.2	4.9	7.4

* Data not available.

were developed as water-storage facilities during the same period. These waters were considered to be generally soft, infertile and acidic (N.Y.S. Dept. Environ. Cons., unpublished data). However, the reservoirs on the Mongaup River may be polluted by untreated and partially treated sewage from upstream sources (Benepe, 1976). Land use on the study area has centered around the generation of hydroelectric power. Most lands surrounding the reservoirs were left alone and not specifically used, although selective lumbering and recreational activities did occur from time to time on the study area.

Operation of the hydroelectric facilities, with their associated water conditions, had made this an attractive wintering location for bald eagles, similar to locations existing on the Mississippi River. Warm subsurface water, taken from the reservoirs and passed through the power-generating facilities, maintained some open water below the dams throughout the winter, as well as a supply of dead or injured fish that provided food for the eagles. Winter sightings of bald eagles have been reported on this area since the early 1950's (Table 3). However, large numbers of birds were not noted until 1972, corresponding to the period of increased public interest in the eagles there.

The Orange and Rockland Utilities Corporation had proposed a limited timber sale adjacent to the Rio Reservoir, but was not actively engaged

TABLE 3. PAST OBSERVATION OF BALD EAGLES ON THE WINTERING AREA IN SULLIVAN COUNTY, NEW YORK

Date	Eagles observed*	Authority
1939 June 26	1	Borko †
1948 August 22	4 (2)	Borko †
1950 August 27	1 (1)	Borko †
1951 December 9	2	Borko †
1952 January 12 §	4	Borko †
1953 February 23 §	4	Borko †
March 3	4	Borko †
April 5	2	Borko †
1954 ?	3	Borko †
1955 ?	3	§
March 1	4	Borko †
1956 November 4	3	Borko †
? §	3	Borko †
1957 ? §	1	Borko †
?	3	§
1958 ? §	1	Borko †
1959 ? §	1	Borko †
1960 ? §	2	Borko †
?	1	§
1961 ?	2	§
1964 ?	2	§
1966 January 1 §	2	Borko (1974)
1967 January 1 §	2	Borko (1974)
December 31 §	1	Borko (1974)
1968 ?	1	§
1969 January 1 §	6	Borko (1974)
1970 January 1 §	4	Borko (1974)
December 26 §	1	Borko (1974)
1971 ?	1	§
1972 January 1 §	8 (3)	Borko (1974)
December 30 §	3 (2)	Borko (1974)
1972-1973	28	Forbes †
1973 January 14	21	Borko †
December 17	21 (11)	N.Y.S. Dept. Environ. Cons.
December 30	11 (6)	N.Y.S. Dept. Environ. Cons.
?	24	Clark †
?	24	Raponi †
1974 ?	11 (6)	§
January 5	14 (7)	N.Y.S. Dept. Environ. Cons.
January 15	6 (2)	N.Y.S. Dept. Environ. Cons.
February 2	10	N.Y.S. Dept. Environ. Cons.
February 9	9 (5)	N.Y.S. Dept. Environ. Cons.
February 27	5	N.Y.S. Dept. Environ. Cons.
February 28	7	N.Y.S. Dept. Environ. Cons.
March 10	1	N.Y.S. Dept. Environ. Cons.
December §	3	Spencer (1976)
1975 ?	3 (0)	§

* Total number observed; figures in parentheses represent number of immature birds when counts for both adults and immatures were given.

§ Data from Audubon Christmas Counts.

† Personal communication

in timber cutting on other portions of the area during the study. Several hunting and fishing clubs either owned land along the Rio Reservoir or leased it from the Corporation. A council of the Boy Scouts of America

also owned a portion of the land along the Rio Reservoir. Housing developments were being established on the Swinging Bridge Reservoir, but only a few older cottages were present on the Mongaup Falls and Rio Reservoirs. Portions of the Mongaup River reservoir system were open for public fishing throughout the year under a cooperation agreement between the Corporation and the State Department of Environmental Conservation. Hunting was also allowed on much of the Corporation lands under a similar agreement.

OBSERVATIONS

The observations upon which this report is based were made between February and April in 1976 and between November 1976 and April 1977. Activities of bald eagles were observed with 7 x 35 binoculars and a 20X spotting scope from a vehicle at various vantage points along the roads and from blinds at strategic points on the Rio and Mongaup Falls Reservoirs and on the Mongaup River below the Swinging Bridge Reservoir.

An aerial survey of the major water bodies in the Catskills, including those on the wintering area, was made in April 1976 to search for eagle nests. A fixed-wing Cessna 172 Skyhawk was used for this survey. After November 1976, a two-seat, piston-drive helicopter was used biweekly to obtain counts and distribution data for bald eagles on and in the immediate vicinity of the study area.

Samples of the fish populations in these waters were collected by personnel of the Department's Bureau of Fish during the summer of 1967 to determine species composition. Collections were made with graded-mesh gill nets, 46-meter trapnets and a 230-volt AC electric shocker used from a boat. Analyses of toxicant levels is fish collected on the study area and in nearby waters during the study were made by the Department's Bureau of Environmental Protection and the Wisconsin Alumni Research Foundation, Inc.

RESULTS AND DISCUSSION

The winter population of bald eagles on the area numbered from 20 to 25, perhaps the largest single concentration in the Northeast. Observations on habitat use, daily activity patterns, prey and feeding behavior and intra- as well as interspecific interaction of the birds were recorded.

PATTERNS OF HABITAT USE

Bald eagles began arriving on the study area in November and increased in numbers as the winter progressed, being most numerous during February (Figure 2). In the fall of 1976, the first observation was an adult bird seen on November 10. During the winter, eagles could be found throughout the tract, but concentration areas seemed to change. Observations indicated that the eagles used Rio Reservoir for roosting and feeding upon arrival in November and December. Later however, use, par-

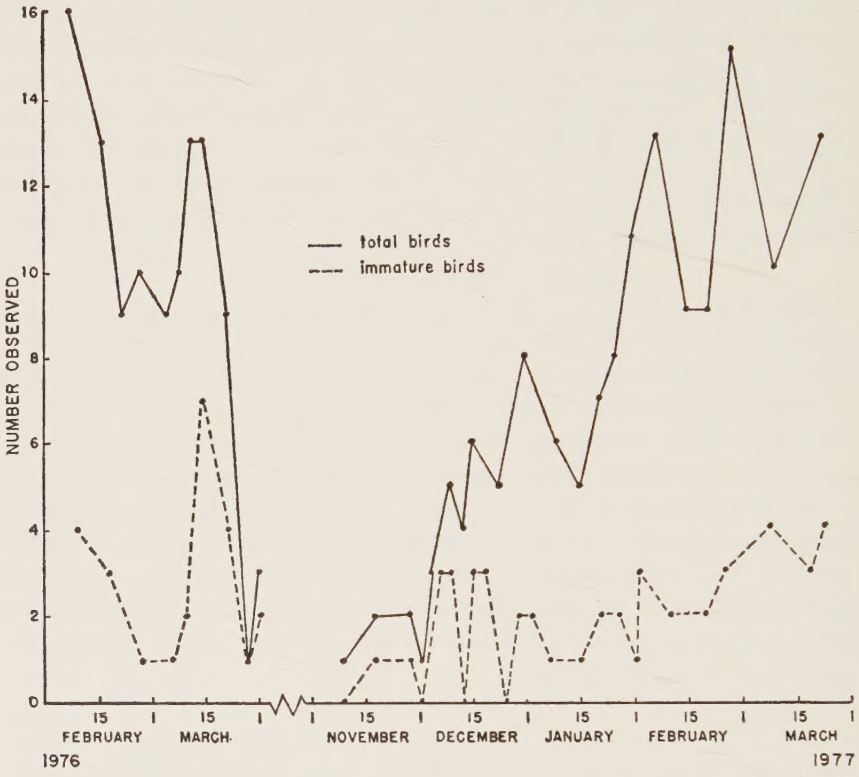

Figure 2. Fluctuations in the number of bald eagles observed on the study area in Sullivan County (N.Y.) from February 1976 to March 1977.

ticularly in regard to feeding, seemed to shift northward to the Mongaup Falls Reservoir and the upper Mongaup River and finally to the Swinging Bridge Reservoir preceding spring dispersal. The vicinity of Rio Reservoir remained the most important roosting area throughout the winter. In 1976 all of the wintering eagles had left the area by March 24, while in the much more severe winter of 1976-77 this did not occur until April 10. Although bald eagles have occasionally been observed on this area during the summer (Gene Raponi, Vern Clark, personal communications), the aerial survey of the major water bodies in the Catskill region, including those on the study area, in April 1976 did not reveal any individuals or nests. Records of bald eagles banded as young in Florida and recovered in New York and farther north (Broley, 1947) indicate that the southern subspecies does migrate northward and may occur in New York during the summer; however, there are no documented records for this subspecies here between November and March. It is believed that the eagles that wintered on the study area dispersed northward out of the State, perhaps to eastern Canada.

Factors causing the distribution of eagles feeding on the area to change over the winter may have included variations in ice conditions, climate, food supplies and availability, or differential power-generating at the various sites within the study area. Open water is necessary for these birds to obtain their major food (fish), and the birds will seek out areas of open water as feeding sites. A lack of open water in one area will cause birds from that area to move to one where there is open water. Thus, the distribution of the bald eagles on this area could have been affected at least during part of the winter by the severity of the weather, water levels and electric-power-generating activities.

DAILY ACTIVITY

The daily activity patterns of bald eagles on the area are illustrated in Figure 3. They closely followed those of wintering bald eagles in the Midwest and West as described by Dunstan (personal communication). Adults tended to have a major feeding period in the early morning and a lesser one in the late afternoon, spending the rest of the day loafing. Immature birds did not follow as consistent a pattern and could be observed fishing or loafing at any time of day. The roosting behavior and daily activity pattern of these eagles was extremely consistent and predictable, particularly for adult birds. The eagles would return to their roost trees 5 to 10 minutes before darkness, and some birds were observed to return to and consistently use the same tree for successive nights, in many cases using the same branch each night. Roosting was communal for this wintering population in that many individuals would roost in the same general location or group of trees; however, no more than one eagle was observed to

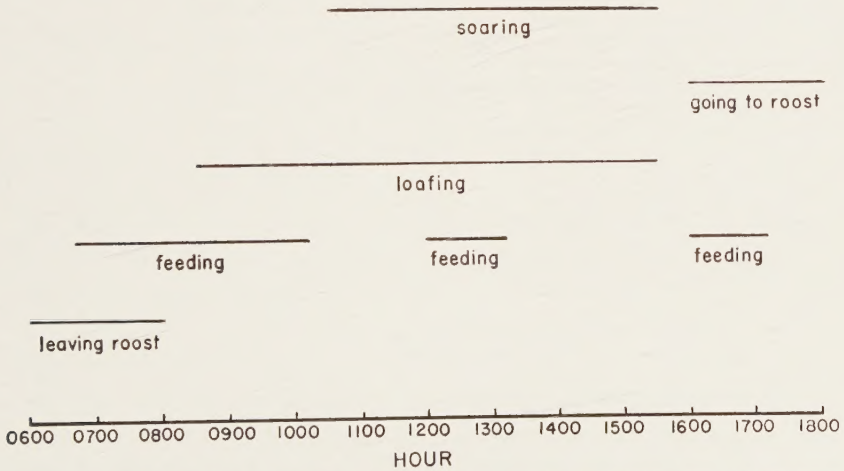

Figure 3. Daily activity patterns of bald eagles on the wintering area in Sullivan County (N.Y.). Soaring occurred on suitable days (sunny, clear and breezy), especially during early fall and late winter.

roost in the same tree. Tall white pines with large horizontal branches were preferred for night roosts. The birds would remain there until morning, and within 5 to 10 minutes of the first skylight they would leave for feeding areas. Although the preferred feeding areas changed during the winter, most of the eagles returned to the western ridges of the Rio Reservoir every evening to roost. Minor roosting locations were identified along the Mongaup River below the Swinging Bridge Reservoir. It is important to point out that not all the bald eagles known to be present on the study area during the day could be accounted for at evening roosts, indicating that there were other important roosting locations in the vicinity.

PREY

Although a great variety of fish were present in the waters of the study area (Table 4), alewives *(Alosa pseudoharengus)* were the predomin-

TABLE 4. SPECIES OF FISH PRESENT IN WATER BODIES ON THE BALD EAGLE WINTERING AREA IN SULLIVAN COUNTY, NEW YORK

Species	Water body							
	Hull Pond	Lake Mcauque	Lebanon Lake	Mongaup Falls Reservoir	Toronto Reservoir	Rio Reservoir	Swinging Bridge Reservoir	Cliff Lake
Alewife *(Alosa pseudoharengus)*				x		x	x	x
Bass, largemouth *(Micropterus salmoides)*		x	x	x	x	x	x	x
Bass, rock *(Ambdoplites rupestris)*				x		x	x	x
Bass, smallmouth *(Micropterus dolomieui)*		x		x	x	x	x	x
Bluegill *(Lepomis macrochirus)*				x	x	x	x	x
Bullhead, brown *(Ictalurus nebulosus)*	x	x	x	x	x	x	x	x
Bullhead, yellow *(Ictalurus natalis)*				x	x	x	x	
Carp *(Cyprinus carpio)*				x	x		x	
Catfish, white *(Ictalurus catus)*				x	x		x	
Crappie, black *(Pomoxis nigromaculatus)*					x		x	x
Fallfish *(Semotilus corporalis)*				x	x		x	
Minnow, cutlips *(Exoglossum maxillingus)*							x	
Perch, yellow *(Perca flavescens)*	x	x	x	x	x	x	x	x
Pickerel, chain *(Esox niger)*	x	x	x	x	x		x	x
Pickerel, grass *(Esox americanus vermiculatus)*							x	
Pickerel, redfin *(Esox americanus americanus)*							x	
Pumpkinseed *(Lepomis gibbosus)*	x	x	x	x	x	x	x	x
Shiner, golden *(Notemigonus crysoleucas)*	x	x	x	x	x	x	x	x
Sucker, creek chub *(Erimyzon oblongus)*			x					
Sucker, lake chub *(Erimyzon sucetta)*	x		x		x			x
Sucker, white *(Catostomas commersoni)*			x	x	x	x	x	x
Sunfish, redbreast *(Lepomis auritus)*		x		x	x	x	x	x
Trout, brown *(Salmo trutta)*				x		x	x	
Eel, American *(Anguilla rostrata)*				x				

ant prey of the bald eagles. Apparently, alewives were either more susceptibl to injury or death from the hydroelectric turbines or were simply more abundant. It is believed that alewives may be extremely sensitive to temperature changes associated with the hydroelectric operations, as was observed by Tagatz (1961) for the American shad *(Alosa sapidissima)* a closely related member of the herring family. He found that shad exposed to an abrupt decrease of 3.9° C. or more in temperature suffered trauma, causing them to float belly-up either stunned or dead. This was precisely the condition in which alewives were found on the study area, and they were often washed up on shore or became imbedded in the ice at the edges of open-water areas on the reservoirs. Alewives were also observed being fed upon by several species of waterfowl including mallards, black ducks, mergansers, goldeneyes and redheads, as well as by crows, herring gulls and raccoons.

While information pertaining to toxicant levels in fish on the study area is spotty and incomplete, the available data seem to indicate very low levels of mercury as well as a drop in PCB levels since 1970 (Table 5). A sample of alewives taken from the Rio Reservoir in December 1976 also showed low levels of mercury and various chlorinated hydrocarbons

TABLE 5. TOXICANT LEVELS IN FISH IN WATERS ON OR NEAR THE BALD EAGLE WINTERING AREA IN SULLIVAN COUNTY, NEW YORK

Water	Species	Year	Number analyzed	Toxicant level (ppm)	
				PCB	Mercury
Rio Reservoir	Largemouth bass	1970	1	..	0.10
	Smallmouth bass	1970	5	..	0.08
Lebanon Lake	Yellow perch	1970	1	..	0.20
	Bullhead	1970	2	..	0.05
Rondout Creek	Largemouth bass	1970	7	5.05	..
		1975	7	1.39	..
	Smallmouth bass	1970	2	14.23	..
	White sucker	1975	5	1.60	..
	Carp	1975	3	1.50	0.04
Rondout Lake	Carp	1970	3	..	0.24
Delaware Lake	Smallmouth bass	1975	2	2.20	..
(at Port Jervis)	White sucker	1975	5	0.90	..

(Table 6). These data indicate this food supply to have been relatively "clean" for these eagles.

FEEDING BEHAVIOR

Four primary fishing techniques were used by bald eagles on the study area. One was to perch in trees near open water and wait until a fish was seen, then swoop down and attempt to pick it out of the water. If a small fish was caught it might be eaten in flight, but a bird usually returned to its perch to consume larger fish. This kind of feeding was usu-

Table 6. Levels of Mercury and Chlorinated Hydrocarbons in Alewives Collected From the Rio Reservoir in December 1976

Substance	Level in ppm
Mercury	0.08
Chlorinated hydrocarbon	
DDE	0.16
DDD	0.17
DDT	0.14
PCB	0.56
Dieldrin	<0.05
BHC	<0.05
Lindane	<0.05
HCB	<0.05
Endrin	<0.05
H.E.	<0.05
Mirex	<0.10
Toxaphene	<0.50
Methoxychlor	<0.10

ally done on the northern portions of the Rio and Mongaup Falls Reservoirs and along the Mongaup River just below Swinging Bridge Dam. Preferred fishing perches were usually leafless deciduous trees with large horizontal branches and few small limbs to interfere with flight.

The second fishing technique, and the one observed to be used the most often, consisted of flying above open water until a fish was located and then diving down and attempting to catch it. Again, if the fish was caught it might be eaten in mid air, or the bird might fly to a perch to consume it, depending on its size. With a fish more than 13 centimeters long, the eagles generally returned to a perch to consume it. This procedure was observed on the Rio and Mongaup Falls Reservoirs and on the Mongaup River below Swinging Bridge Dam. These two methods were used most often by adult bald eagles during the winter, but immature eagles were also seen using them, especially in the early spring.

In the third technique the birds stood on the ice near open water and searched for fish imbedded in the ice or pulled wounded or dead fish out of the water as they floated by. When a fish frozen in the ice was located, the birds would peck and work at the ice with their beaks in an effort to free it. Eagles obtaining food in this manner were observed on the Rio and Mongaup Falls Reservoirs. Both adults and immature birds used this method, but it was the primary technique of immature birds during the severe winter months. Immature birds were observed to stand on the ice for up to 4 hours at a time waiting for a fish to float by. This fishing technique was the most successful in consistently capturing fish, but it was not necessarily the most efficient since a great deal of time was sometimes spent before a fish was actually taken.

The last feeding technique was similar to the previous one in that the birds stood on grass hummocks in the river below Swinging Bridge Dam

and picked up wounded and dead fish as they passed by. Only immature eagles were observed to feed this way.

Occasionally the eagles would harass mergansers, goldeneys, mallards or black ducks that had caught fish, in what appeared to be an attempt to steal the fish from the waterfowl. Although bald eagles have been observed to steal fish from mergansers (Grubb, 1971), they were not known to have been successful in this on the study area.

Loafing behavior was observed throughout the day when the eagles were not feeding. It consisted mostly of long periods of inactivity during which the birds would remain perched simply surveying their surroundings, but sometimes it took the form of soaring, especially on sunny days and in the late winter.

Interactions

Intraspecific interactions between bald eagles were observed during feeding and perching activities, mostly while the birds were fishing on the ice when individuals would often be attracted to other individuals that had caught fish. Birds were observed to walk as much as 10 meters to another that had caught a fish. The bird with the fish would usually not tolerate the intrusion and would jump at and often strike the intruder with its talons and outspread wings. At times the intruder would be quite persistent in its attempts to approach the fishing spot. This intrusion-attack interaction was once observed seven times between an immature intruder and a feeding adult over a period of 20 minutes. One eagle would sometimes dive toward another that had caught a fish from the air, but the intruder usually veered off before interaction occurred. Some chasing, mock dives, aerial acrobatics and attacks between high-flying or soaring individuals were also noted.

Suitable perch trees were limited in the vicinity of favorite fishing locations on the study area. Displacement of perched individuals by newcomers to a perch was occasionally observed, but there was generally little interaction among perched birds during the day, even though more than 10 individuals might be using the same tree. Often two individuals would perch on the same branch within a meter of each other. Limited interaction was observed at night roosts. However, in contrast to daytime perching, no more than one bird was seen to roost in the same tree.

Observations of interactions between bald eagles and other forms of wildlife were limited. As already mentioned, eagles would occasionally dive at waterfowl that had caught fish. Crows were observed to severly harass immature bald eagles, but not adults. The eagles largely ignored the crows and did not retaliate.

The most important interspecific encounters observed occurred between bald eagles and humans. A significant amount of vehicular traffic occurred on the roads adjacent to eagle concentration areas. Much of this activity was associated with operation of the hydroelectric facilities, and the eagles did not appear to be adversely affected by it. However, the birds did not tolerate people on foot. People were observed to flush perched eagles up to 0.4 kilometer away. Over-zealous birdwatchers appeared to cause the greatest disturbance, especially on weekends when birds were continually flushed from feeding areas and perches. Upwards of 200 persons have been observed on the study area on weekends for the purpose of viewing the eagles (Vern Clark, personal communication). The eagles could be easily observed from vehicles parked on established roadways, but continual attempts to "get a little closer" on foot invariably flushed them. Other human activities that disturbed the birds included snowmobiling on the frozen reservoirs and the use of power ice-drilling augers in connection with ice fishing near the eagle concentration areas. Although small aircraft frequently flew over the study area, they did not seem to disturb the eagles.

MANAGEMENT IMPLICATIONS

Three habitat components were found to be critical to the continued presence of bald eagles on the study area: suitable night roosts, day perches and feeding sites. Large white pines along much of the western bank of the Rio Resrvoir provided attractive night roosts for most, if not all, of the bald eagles on the area. The location of these trees, below the crest of the western ridge, afforded protection for the birds from the prevailing westerly winds. Maintenance of this section of forest to provide suitable night roosts for the wintering eagles is considered vital to proper management of the area for this species. Suitable perching and loafing trees near feeding areas are equally important. Deciduous trees with large horizontal branches and few small limbs to interfere with flight best serve this purpose, and the availability of such trees is also considered important.

The presence of bald eagles on this area was directly related to the utility company's activities. Ice-free feeding areas and injured fish were the prime factors in attracting the birds to this site, and continued operation of the hydroelectric facilities is essential if these conditions are to be maintained. This is a unique case where man's influence on the environment has worked to the advantage of an endangered species and where the lack of that influnce could be detrimental.

There are a number of potential threats that may put this unique area in jeopardy. For example, land taxes on the area are becoming an increas-

ing burden to the Orange and Rockland Utilities Corporation, which derived 3.5 per cent of its total power production from this area in 1975 (Benepe, 1976), especially during periods of peak demand. This factor could lead to the sale or other disposal of certain lands critical to the welfare of this eagle population. In addition, timber harvests on the area could seriously impair important eagle habitat. Also, the ramifications of development based solely upon economic considerations could be disasterous for this population of wintering bald eagles. Of further concern is a consideration by the utilities corporation of possible construction of twin 1,300-megawatt nuclear-fueled power plants between Cliff Lake and Swinging Bridge Reservoir and twin 150-megawatt pumped-storage hydroelectric plants between Lake Metauque and Rio Reservoir. If this were done, it is anticipated that these additional facilities would allow this site to supply substantial amounts of the Corporation's total power production (D. Barnes, personal communication). The effects of such new facilities on wintering eagles, either positive or negative, cannot be predictd and would need to be evaluated.

Construction and operation of the proposed nuclear plant might not adversely affect any of the areas presently considered critical for the bald eagle population. Operation of the pumped-storage facility might provide some additional open water, but the construction site would be centered on the main roosting area (on Rio Reservoir) and could have an extremely detrimental effect on the eagles if these roosts were destroyed. The proposal to include the bald eagle as an endagered species under Federal regulations (U.S. Fish and Wildlife Service, 1976) could have a significant effect on the development of these two facilities. If this area were designated as critical bald eagle habitat and if Federal funds were involved in the construction or operation of the facilities, Section 7 of the Federal Endangered Species Act of 1973 which requires that development not "jeopardize the continued existence of such endangered species . . . or result in the destruction or modification of habitat" would apply, and a thorough analysis of the environmental impact of the construction planned would be required.

Observation of the bald eagles by the public and disturbance of the birds often associated with it presents another problem. Although access to a major portion of the area is restricted, people continually leave their vehicles to approach feeding and perching locations thereby flushing the birds. It is highly desirable that birdwatchers remain in their vehicles on the established roadways or at designated viewing sites. Although this would mean viewing the birds at a greater distance, extended observations would be possible and more people would be able to observe the eagles throughout the day.

This site affords the opportunity to preserve one of the most important wintering areas for bald eagles in the Northeast, and the paramount factor in maintaining it is continued operation of the hydroelectric facilities. If the power company should be unable to do this, one possible solution would be purchase of the area by the government or by a private conservation organization. A more feasible approach might be to obtain from the Orange and Rockland Utilities Corporation, by grant or purchase, a permanent easement that would give the Department control of land use on the areas of critical eagle habitat, thereby lessening the tax burden on the corporation and enabling it to continue its operation there.

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EMIGRATION OF JUVENILE RAINBOW TROUT IN CAYUGA INLET, NEW YORK[1]

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ABSTRACT

Rainbow trout were captured by means of a downstream trap incorporated into an existing fishery on Cayuga Inlet (N.Y.) from August 1, 1973 to August 1, 1974. A total of 114 juveniles were captured, 79 per cent of which emigrated between May 9 and June 6. Emigration occurred on rising water temperature and falling water level. Of the emigrants, 61, 23 and 16 per cent were age 1+, age 2+ and age 3+, respectively. Among the age 1+ fish, emigrants were larger at the formation of the first annulus and had more widely spaced circuli than did non-emigrants of the same year class.

The natural reproduction of anadromous rainbow trout *(Salmo gairdneri)* in the tributaries of Cayuga Lake (N.Y.) supports a substantial sport fishery for this species. Although the life history and management of rainbow trout in the Finger Lakes of New York has been extensively studied (Hartman, 1959; Rayner, 1941), there are negligible data on the emigration of juveniles from spawning streams into the lake. Such information is necessary for the proper management of the rainbow trout fishery in Cayuga Lake.

Cayuga Lake, like all the Finger Lakes, is long, narrow and deep, and has a north-south orientation. Tributaries along the eastern and western sides have impassable falls within 2 kilometers of their mouths. Cayuga Inlet, the southern tributary, has 30.4 of the 54.4 kilometers of its major tributaries unobstructed by falls (Seifert, 1968) and is the major spawning tributary for the Cayuga Lake stock of rainbow trout.

Duration of stream life for anadromous populations of rainbow trout varies considerably (Kwain, 1971). The fish spend 1, 2 or 3 years in the stream environment before descending to the lake. The age structure of emigrating juveniles may thus vary considerably between populations. Until the present study, the age at emigration of juveniles in Cayuga Inlet had been inferred from the scales of spawning adults (John Boreman, per-

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sonal communication) as has been done elsewhere (Maher and Larkin, 1955; Hartman, 1959; Dodge and MacCrimmon, 1970; Kwain, 1971). Stream growth is represented by crowded circuli in the nuclear area of the scale, while relatively wider-spaced circuli beyond this nuclear area represent lake growth. The age structure of the emigrants obtained by this indirect method may not be the same as that resulting from direct sampling of the outmigration as was found by Alexander and MacCrimmon (1974). Knowledge of the exact age structure of emigrating juveniles would be necessary to make estimates of survival in the lake.

This study of the emigration of juvenile rainbow trout in Cayuga Inlet was undertaken to determine the age and time of year that the juveniles move to Cayuga Lake. A second objective was to investigate possible differences in growth between emigrant and non-emigrant rainbow trout of a given year class, since growth of the juvenile fish is likely a factor in determining whether an individual will emigrate or remain in the stream for another year (Stauffer, 1972). The relationship between juvenile emigration, water flow and temperature fluctuations in Cayuga Inlet was also investigated.

Traps designed to monitor the emigration of juvenile rainbow trout were installed at the fishway drop structure on Cayuga Inlet (Webster and Otis, 1973) from August 1973 to August 1974. A temporary trap was in operation from August 1 to October 9 after which a more permanent trap that also allowed for the simultaneous passage of upstream spawners was incorporated into the basic design of the fish-passage facilities. Downstream migrants that were captured in the trap were released below the fishway drop structure, thus preventing recycling of fish through the trap. The trap was checked and cleaned daily because high water and debris were constant problems in the fall and spring. The trap was inoperative from December 15 to March 27 due to ice conditions and from March 31 to April 7 and April 11 to 15 due to high spring discharge.

All emigrants were counted and measured to the nearest millimeter (total length). Scale samples for aging were taken below the posterior insertion of the dorsal fin just above the lateral line. Hartman (1959) demonstrated that scale reading is a reliable method for aging juvenile rainbow trout in the Finger Lakes. Scale samples were independently read twice. Total agreement was 92 per cent.

Water temperature was monitored at the fishway drop structure by a continuously recording thermometer. Water level immediately upstream of the flood-control structure was measured by observing a permanently mounted water-level gauge. Water level was recorded daily and was assumed to be an index of water flow.

Juvenile rainbow trout were sampled from June 4 to 7 in the headwaters of Cayuga Inlet by electrofishing (120 volts D.C. at 120 pulses) to obtain data on non-migrating juveniles. Length measurements and scale samples were taken as already described.

To test whether emigrants were larger at a given age than non-emigrants of the same year class, lengths to the last stream annulus for both groups were back-calculated and compared. Only age 1+ fish (1973 year class) were compared because of the small samples of older fish. Also, this eliminated possible growth differences between years. Lengths to the age 1 annulus were back-calculated using the proportion method, in which

$$L_1 = C + \frac{R_1}{Rc} \quad (Lc - C)$$

where:

C = correction factor based on body length-scale radius regression
R_1 = radius at annulus 1
Rc = radius at capture
Lc = fish length at capture
L_1 = computed length at annulus 1

Scale samples were not taken for three emigrants, and one other had regenerate scales. One non-emigrant was discarded because of regenerate scales. Mean lengths of emigrants and non-emigrants were also compared. Only emigrants captured after May 30 were used to make the samples comparable.

The spacing of scale circuli is correlated with growth rate (Gray and Setna, 1931; Bilton and Robins, 1971). Circuli spacing on the scales of age 1+ emigrants and non-emigrants was compared by testing for differences in the ratio of the number of scale circuli to the scale radius for each group. Circuli on each scale were counted from the nucleus to the margin of the anterior field of the scale along the longest axis. The number of circuli to the age 1 annulus was also noted.

RESULTS

A total of 114 juvenile rainbow trout were captured in the downstream trap. Catches of emigrating juveniles were greatest from mid-May to the first week in June, peaking on June 2 (Figure 1). Nine juvenile trout emigrated in the fall and are not shown. The daily catch of emigrants fluctuated markedly but, since only one year's data were available, it is difficult to be certain of the effects of changing environmental parameters. Most fish emigrated on an increasing water temperature and

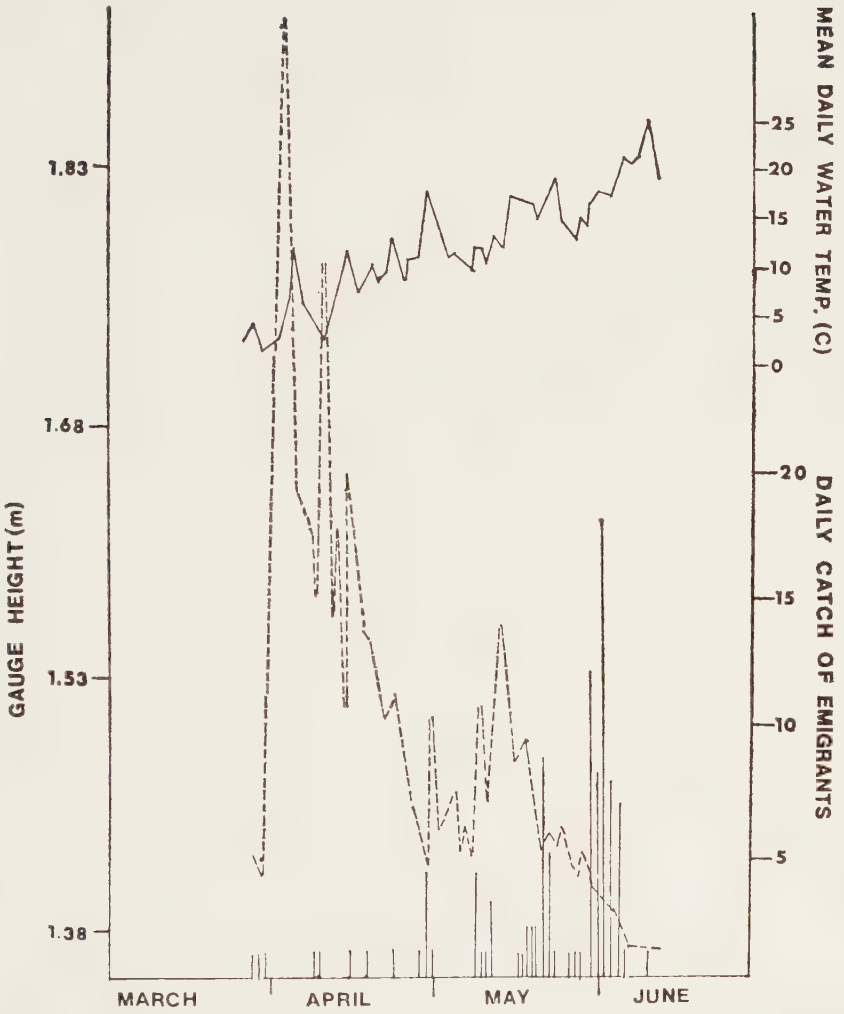

Figure 1. Daily catch of emigrant juvenile rainbow trout (vertical bars) in Cayuga Inlet in 1974 together with concurrent data for water temperature (solid line) and water guage height (dash line).

decreasing water level (Figure 1). There was, however, a correlation between temperature and flow, so it is difficult to separate their individual effects.

Ages were determined for all juveniles captured in the downstream trap and by electrofishing. Fish that were captured in late February and March showed marginal annuli. Hartman (1959) stated that annulus formation in Finger Lakes rainbow trout occurred in late March. Age 2+ and 3+ fish overlapped greatly in size (Figure 2) as was found by Shapovalov and Taft (1954) in Waddell Creek in California. Agree-

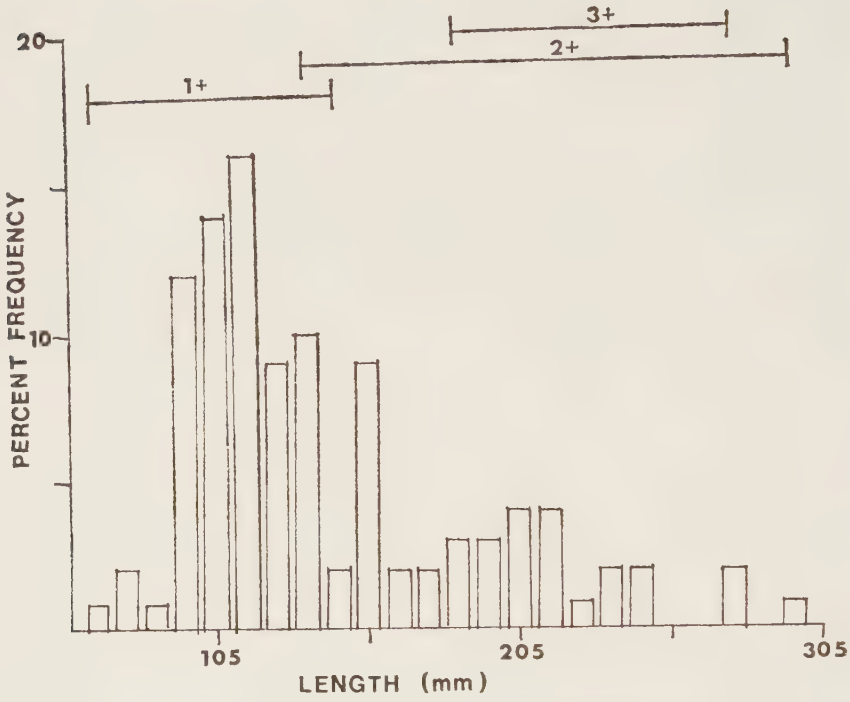

Figure 2. Length-frequency distribution for 105 emigrant juvenile rainbow trout captured in Cayuga Inlet in 1974. Horizontal lines represent ranges of length by age.

ment between the two scale readings was good (92 per cent), and most of the differences were in distinguishing age 2+ from age 3+ fish.

Of the juvenile emigrants, 61 per cent (64) were age 1+ with a mean length of 110 ±16 millimeters, while 23 per cent (24) were age 2+ with a mean length of 167 ± 35 millimeters and 16 per cent (17) were age 3+ with a mean length of 217 ± 27 millimeters. These data do not include the nine fall migrants. This age structure differed from that of emigrants as inferred from the scales of spawning adults which averaged 28 per cent for age 1+, 68 per cent for age 2+ and 4 per cent for age 3+ (John Boreman, personal communication).

In the upper reaches of the stream, 87 juveniles were collected by electrofishing. In this case, 96 per cent (84) were age 1+ with a mean length of 107 ±16 millimeters. Two fish were age 3+ with lengths of 210 and 230 millimeters, and one was age 4+ with a length of 248 millimeters. Trout sampled upstream are referred to as non-emigrants because collections were made after June 2, the peak of emigration (Fig-

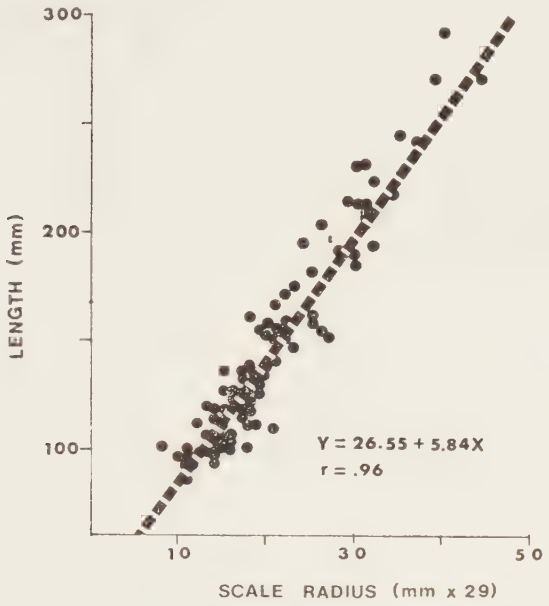

Figure 3. Body length-scale radius regression for emigrant juvenile rainbow trout in Cayuga Inlet in 1974.

ure 1). The preponderance of age 1 + fish in the upstream samples may have been due to the emigration of older trout from the headwater areas to the lower portion of the stream or out to the lake.

A linear model was used to describe the body length-scale radius regressions for both emigrants (Figure 3) and non-emigrants (Figure 4). An analysis of variance showed that the regression coefficients differed from each other ($P<0.05$). Whitney and Carlander (1956) doubted whether the body length-scale radius regression is ever linear but stated that if the sample is small, as was the case in this study, computing a curvilinear regression may not be justified. In addition, a plot of the residuals (observed length minus predicted length against the scale radius revealed no significant trend. Draper and Smith (1966) stated that an over-all impression of a horizontal band of residuals is regarded as satisfactory.

For the mean back-calculated lengths at the age 1 annulus, there was a statistically significant difference between emigrants (60) and non-emigrants (83), i.e., 81.40 ± 8.82 millimeters vs. 77.27 ± 11.55 milli-

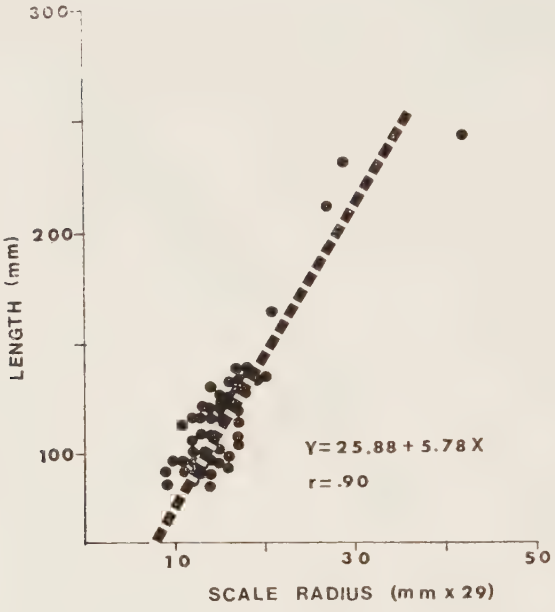

Figure 4. Body length-scale radius regression for non-emigrant juvenile rainbow trout in Cayuga Inlet in 1974.

meters, respectively, ($t = 2.31$, $P = 0.05$). The difference is illustrated in Figure 5. At the time of emigration also, the emigrants (40) were significantly larger than the non-emigrants (84), i.e., 114 $\pm$ 13 millimeters vs. 107 $\pm$ 16 millimeters, respectively, ($t = 2.62$, $P = 0.05$).

Emigrants had significantly fewer circuli per unit of scale radius (1.26 $\pm$ 0.16 for 60 specimens) than non-emigrants (1.39 $\pm$ 0.21 for 83 specimens); ($t = 4.02$, $P = 0.05$), when the ratio of total scale circuli to total scale radius was used. After the age 1 annulus, however, there was no significant difference in the ratio of scale circuli to scale radius, i.e., 1.66 $\pm$ 0.51 vs. 1.77 $\pm$ 0.51 for the same specimens of emigrants and non-emigrants, respectively; ($t = 1.27$, $P = 0.05$). Predictably, emigrants had significantly fewer circuli per unit of scale radius when only the nuclear area of the scale was used, i.e., 1.08 $\pm$ 0.19 vs. 1.24 $\pm$ 0.27 for the two groups, respectively; ($t = 3.53$, $P = 0.05$).

Hartman (1959) showed that, for adult rainbow trout of the same age group in Seneca, Skaneateles and Keuka Lakes (N.Y.), those that had spent two years in the stream were shorter, on the average, than those

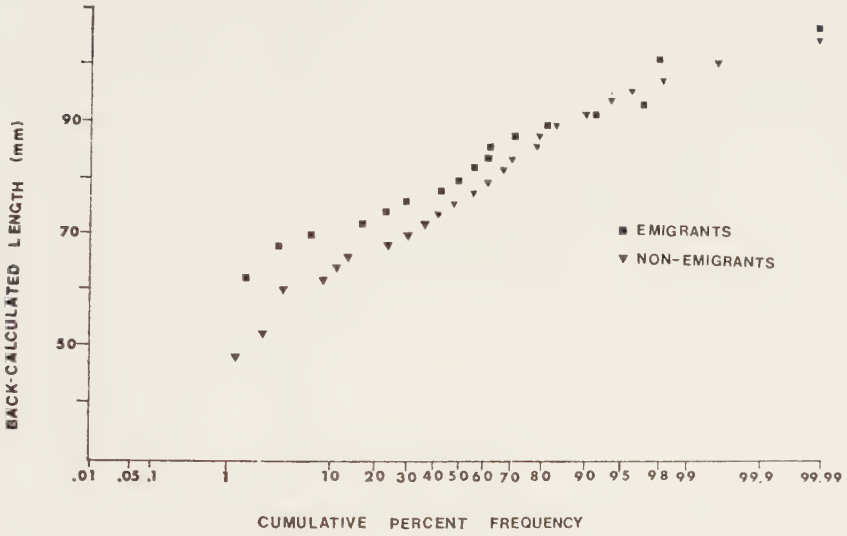

Figure 5. Frequency distribution of back-calculated lengths at the age 1 annulus for emigrant and non-emigrant rainbow trout in Cayuga Inlet in 1974.

that had spent only one year there. In the present study, the mean empirical lengths at a given age for adults with two stream years were compared with those of adults with one stream year for specimens from the spawning run in Cayuga Inlet in the spring of 1973 as previously recorded under another phase of the project (Figure 6). Fish with one stream year were larger ($P < 0.05$) at ages 3 and 4 than fish with two stream years. No differences were detected ($P > 0.05$) for older trout, indicating that growth compensation had taken place.

In June 1972, Hurricane Agnes destroyed that year's production of rainbow trout or swept them prematurely into the lake (D. A. Webster, personal communication). The large numbers of 2-year-old fish that ascended Cayuga Inlet in the fall of 1974 indicated the latter to have been the case. Theoretically, these fish should have shown no stream growth in the nuclear area of their scales. The nuclear area on the scales of two groups of fish (61 in each group) of the same life history category (one stream year and one lake year) were examined. The first group comprised fish of the 1972 year class returning in the fall of 1974 (mean length = 301.3 ± 21.5 millimeters), and the second group comprised fish from year classes between 1969 and 1971 (mean length = 416.6 ± 54.7 millimeters). All the fish examined had a nuclear area on their scales that resembled stream growth, but that for fish of the 1972 year

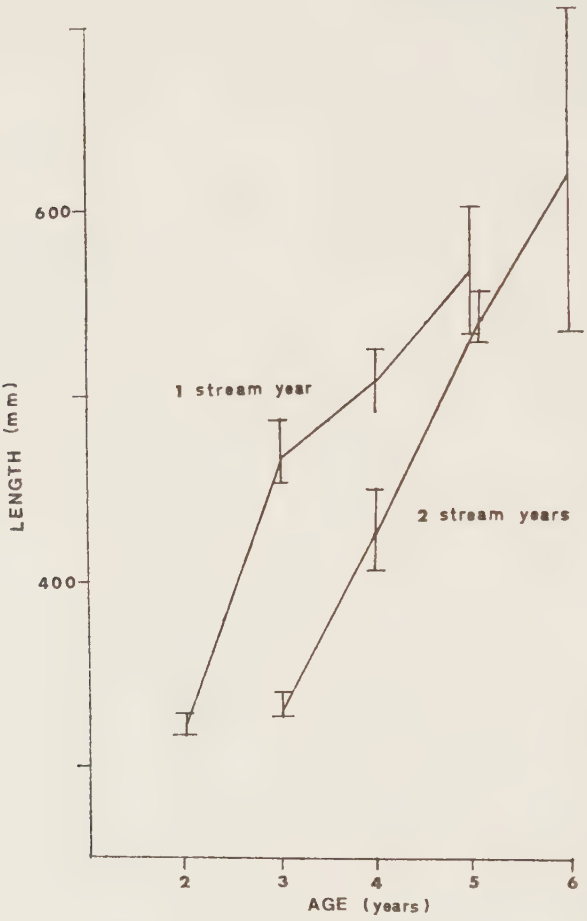

Figure 6. Length-age relationship for adult rainbow trout that had spent one year in the stream before emigration compared with that for fish that had spent two years in the stream. Bars represent 95 per cent confidence limits. Derived from data for 312 fish taken during spawning run in Cayuga Inlet in 1973.

class was significantly smaller ($P < 0.05$) than that for the earlier year classes. The percentage frequency distribution bore out this relationship (Figure 7).

DISCUSSION

Emigration of juvenile rainbow trout in Cayuga Inlet occurred predominantly in May and early June, approximately the same time as has been found in other studies. In the Black River in Michigan, peak emigration was from late May to early June (Stauffer, 1972), as was found in Cayuga Inlet. Shapovalov and Taft (1954) found that in Waddell Creek in California most steelhead smolts emigrated from April

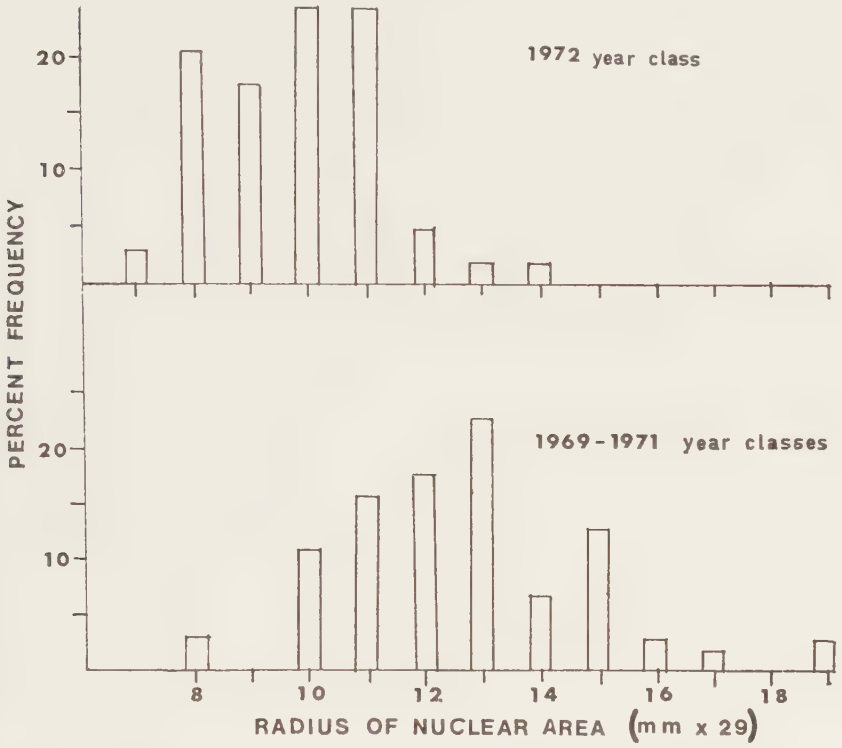

Figure 7. Frequency distribution of the anterior radius of the nuclear area of the scales of rainbow trout with one stream year and one lake year for 61 fish of the 1972 year class compared with that for 61 fish from the 1969 to 1971 year classes taken in Cayuga Inlet.

to early June but that there was a secondary migration in late fall or early winter. There may be a fall emigration in Cayuga Inlet as nine emigrants were captured in November and December in 1973. However, Alexander and MacCrimmon (1974) reported that few resident trout emigrated prior to April 7 in Bothwell's Creek in Georgian Bay in Ontario.

The findings of the present study contrast with those of Hartman (1958) who concluded that the bulk of emigration in Grout Brook and Cold Brook, two other Finger Lakes tributaries, occurred in early spring. He interpreted widely spaced circuli following the last stream annulus to imply that parr emigrated to the lake early in the growing season after annulus formation. This difference emphasizes the need to examine the smolt run directly.

In the present study, age 1+ emigrants predominated when outmigration was sampled directly, in contrast to evidence from the scales of adult

spawners which showed that a larger percentage spent two years in the stream. There are two possible reasons why age 1+ emigrants predominated in the 1974 downstream migration in Cayuga Inlet. First, in June 1972, Hurricane Agnes struck upstate New York and eliminated most of that year's production from the stream (D. A. Webster, personal communication). Hoopes (1975) noted that this storm destroyed 96 per cent of marked young-of-the-year brook trout *(Salvelinus fontinalis)* between preflood and postflood samples. Second, although the age structure of emigrants within a given population is likely constant over time, that between populations probably varies. Duration of stream life varies between rainbow trout populations (Kwain, 1971). Some studies have shown that most fish emigrate at age 2+ (Maher and Larkin, 1955; Chapman, 1958). Van Velson (1974), however, found that the growth rate in tributaries of McConaughy Reservoir in Nebraska was rapid enough to cause 92 per cent of the emigrating juveniles to be age 1+, and perhaps this was the case in Cayuga Inlet.

Kwain (1971) stated that there is an inverse relation between size at age X and duration of stream life. In Cayuga Inlet, larger age 1+ trout of the 1973 year class emigrated to the lake, while smaller age 1+ trout of the same year class remained in the stream. The survival rate of larger emigrants may be higher than that of smaller ones. Foerster (1954) showed that the percentage return of adult sockeye salmon *(Oncorhynchus nerka)* increased as the size of the smolts increased. Wagner et al. (1963) stated that the survival rate for the fastest-growing fish of any given hatchery lot of yearling steelhead trout was greater than that for slower growers.

Wider spaced circuli in the scales of emigrant trout implied that they grew faster than non-emigrants. Their growth, based on circuli spacing, was significantly faster up until formation of the first annulus. After annulus formation, circuli spacing was not significantly different, implying equal growth rates. Faster growth rates early in life would cause emigrants to be larger than non-emigrants as was the case.

The total concept of determining a fish's life history from its scales needs to be critically evaluated. Stream growth was evident on fish of the 1972 year class even though they, in all likelihood, may have been swept into the lake before their scales were even formed. For some reason, possibly a lack of sufficient food, these fish grew slowly during their first year of life. This phenomenon needs to be examined more closely.

In general, the earlier the age of first reproduction, the higher the rate of increase of a population (Cole, 1954). Emigration of juveniles at an early age would be advantageous to the total population, in terms of an

increased rate of population increase, because the trout would return sooner to spawn. Kwain (1971) stated that the rainbow trout in Lake Superior require a certain amount of lake growth for maturation no matter at what age they descend and found that regardless of the duration of stream residence most fish spent two years in Lake Superior to reach maturity. However, there may be a comparatively high mortality in the lake among juveniles that emigrate at age 1+. Differential survival in the lake may have been the cause of the proportion of fish with one stream year among returning adults being lower than the proportion of emigrants that descended as one year olds. A positive correlation between smolt size and percentage return of adults was found for steelhead trout (Wagner et al., 1963) and sockeye salmon (Foerster, 1954). Therefore, there may be survival advantages to remaining in the stream for another year or two and descending as a larger emigrant. The advantages of early maturation of young emigrants may be offset somewhat by their possibly low survival, compartively, in the lake. The presence of older fish in a given year's lot of emigrants may ensure that some fish will return to spawn after the appropriate maturation time is spent in the lake. Thus, the best interests of the population, in terms of adults returning to spawn, are served.

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ORGANOCHLORINE RESIDUES IN RAPTOR EGGS IN THE CAYUGA LAKE BASIN[1]

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ABSTRACT

Organochlorine residue burdens and eggshell thinning in the eggs of hawks and owls nesting in the Cayuga Lake Basin in central New York were compared. Except for those of the buteos (red-tailed hawk, red-shouldered hawk and broad-winged hawk), all the eggs examined contained high, but variable, DDE levels. Values in eggs of the red-tailed hawk ranged from approximately 2 to 14 ppm, and those for other buteos fell within this span. Eggs of the screech owl, American kestrel and Cooper's hawk contained intermediate mean residue levels (12 to 67 ppm). The highest mean DDE level and the highest DDE level in an individual egg were exhibited by the great horned owl (102 and 248, respectively). Limited data on residues are also presented for dieldrin, heptachlor epoxide and PCB's. Data on eggshell thinning indicated that there had been little decrease in shell thickness for eggs of the buteos, while for eggs of the great horned owl and American kestrel shell thickness had decreased about 10 per cent. The Copper's hawk exhibited the greatest increase in the degree of eggshell thinning (19 per cent), and its situation may be critical. The ecological factors responsible for residue differences between hawk-owl counterparts, as well as needed research, are discussed.

The environmentally persistent and biochemically lipophilic nature of organochlorines is well documented (Noakes and Benfield, 1965; Ecobichon and Saschenbrecker, 1968; Herman et al., 1968; Dimond and Sherburne, 1969; Sherburne and Dimond, 1969). These qualities commonly cause "biological magnification" (Hickey et al., 1966) which, in turn, results in inordinate residues at higher trophic levels.

Although accumulation of organochlorines by raptors provides rather classic examples of biomagnification (Hickey and Anderson, 1968; Hickey, 1969; Fyfe et al., 1969; Berger et al., 1970; Enderson and Berger, 1968, 1970; Lincer et al., 1970; Cade et al., 1971; Temple, 1972; Snyder et al., 1973; Lincer, 1975), there has been little comparative study of hawks and owls involving several species within a limited geographic region. However, whenever the two groups have been compared with respect to residues in their eggs and/or eggshell thinning, a difference has been noted

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(Hickey and Anderson, 1968; Seidensticker and Reynolds, 1971). Since very little work concerning residues pertained to the nocturnal raptors and since they have the potential for a very different prey pool and biochemical approach to digestion (Clark, 1972) and possibly pesticide metabolism, an effort was launched to compare residue levels and eggshell thinning in the eggs of trophically similar representatives of the Falconiformes and Strigiformes. Because the work described here was carried out tangentially to two other major projects (Lincer, 1972, 1975; Clark, 1975) and was prematurely terminated because of a lack of funds and consequent relocation of the investigators, the sample sizes fell short of original expectations. Although the data do not reflect the intensive and extensive nature of the planned project, the authors feel that the findings are important to raptor management and hope that they will stimulate further effort by others.

METHODS

The study was carried out in the Cayuga Lake basin in central New York, primarily during 1971 and 1972. Because of the early nesting of the great horned owl *(Bubo virginianus)*, field work (i.e., nest finding) was begun in January each year. Data were gathered concerning all species of hawks and owls for which observable nests were found. Each nest was observed at least once a week to determine the stage of reproduction and normal behavior of the nesting birds as well as factors other than pesticide contamination that might ultimately contribute to the failure of that nesting attempt. During these visits, prey taken by the raptors was identified in the field whenever possible, while pellets and prey remains were collected for subsequent identification (R. J. Clark, unpublished). One egg from each nest was collected immediately after clutch completion. This was done: (1) to maintain consistency of sampling and to reduce differential metabolic effects of varied degrees of embryonic development as described by Kreitzer (1972); and (2) to maximize the possibility that, if the pair abandoned this nest, they would renest and thereby lessen the adverse effects on the raptor population.

Eggs were measured for breadth and length to the nearest 0.1 millimeter with a Mitutoyo No. 505-633 caliper equipped with a vernier, and were then either stored temporarily in a refrigerator (at +5° C.) or blown immediately to remove their contents. Shells were broken in half at the equator and washed with lukewarm water, care being taken not to disturb the shell membranes, after which they were allowed to drain for approximately 30 seconds. Shell thickness at the equator was then measured to the nearest 0.005 millimeter with an Ames No. 25ME thickness gauge. A minimum of four measurements were taken for each shell half.

High and low extremes were discarded, and an average shell thickness was recorded. Since this procedure may have differed from that of other investigators, comparisons based solely on the data for millimeter thickness should be made with caution. A second parameter, Ratcliffe's Index or RI (Ratcliffe, 1967), which reflects shell thickness and/or shell weight per unit of surface area was also recorded. The RI was calculated as the weight of the dried eggshell in milligrams divided by the length times the breadth in millimeters.

The procedures followed for analyzing residue were essentially those reported by Cade et al. (1971), with slight modifications as described by Lincer (1972, 1975). Although the relatively high DDE residues tended to mask residues of polychlorinated biphenyls (PCB's), when initial chromatograms indicated the latter to be present, PCB's were physically separated from DDE before the final determinative step by using the silica-gel column chromatography technique of Snyder and Reinert (1971). PCB's were, however, not quantified, except in kestrel eggs during 1970. Two gas chromatograph columns, filled with liquid phases of different polarities, were used simultaneously. Quantification was based on peak height since desired compounds eluted early with symmetrical peaks. The micrograms of residue in each sample were calculated for both columns, and the lower of the two values was routinely chosen as the basis for expressing parts per million. Agreement between columns was usually within 15 per cent. Recoveries of common organochlorines (e.g., p,p'-DDE,-TDE and -DDT) based on sample fortification exceeded 88 per cent. No corrections were made for recovery.

RESULTS AND DISCUSSION

The data (Table 1) indicate that, except for the buteos, all the raptors sampled were accumulating relatively high, but variable, levels of DDE. Although sample sizes would have to be increased appreciably to allow adequate determination of within-species variation, a few interesting comparisons may be noted. For instance, the eggs of trophically similar species, like the screech owl and American kestrel, had somewhat comparable levels of all residues. The higher DDE residues in kestrel eggs probably resulted from accumulations on their wintering grounds in the southeastern United States (Lincer, 1975). Unlike the similarity shown for great horned owls and red-tailed hawks in Montana by Seidensticker and Reynolds (1971), the eggs of these owls analyzed during the present project appear to have contained more than an order of magnitude more DDE than those of their red-tailed hawk counterparts in the Cayuga Lake basin.

TABLE 1. ORGANOCHLORINE LEVELS IN RAPTOR EGGS FROM THE CAYUGA LAKE BASIN

Species	Year	Organochlorine							
		Dieldrin		Heptachlor epoxide		DDE		PCB's	
		Number*	Mean ppm§	Number*	Mean ppm§	Number*	Mean ppm§	Number*	Mean ppm§
Red-tailed hawk *(Buteo jamaicensis)*	1971	3	0.21 ± 0.34 (0.01 — 0.60)	1	none detectable	4	5.65 ± 5.49 (1.87 — 13.8)	##	##
Red-shouldered hawk *(Buteo lineatus)*	1972	##	##	##	##	1	4.39	##	##
Broad-winged hawk *(Buteo platypterus)*	1971	1	0.65	1	none detectable	1	5.83	##	##
Cooper's hawk *(Accipter cooperi)*	1971	##	##	##	##	2	67.6 ± 23.9 (50.7 — 84.5)	##	##
American kestrel *(Falco sparverius)*	1970	5†	2.70 ± 4.19 (none — 9.70)	##	##	22†	41.9 ± 25.8 (8.78 — 100)	5†	37.0 ± 56.0 6.72 — 137)
	1971	7†	0.15 ± 0.22 (tr. — 0.64)	7‡	0.02 ± 0.06 (none — 0.15)	6†	33.2 ± 16.4 (18.3 — 64.9	##	##
	1972	##	##	##	##	5†	36.8 ± 8.37 (12.6 — 74.9)	##	##
Great horned owl *(Bubo virginianus)*	1972	##	##	##	##	3	102 ± 126 (21.8 — 248)	##	##
Screech owl *(Otus asio)*	1970	##	##	3‡	##	2‡	22.4 ± 7.20 (17.3 — 27.5)	##	##
	1971	3‡	0.19 ± 0.11 (0.07 — 0.29)	2‡	0.09 ± 0.13 (tr. — 0.18)	3‡	12.46 ± 2.14 (10.9 — 14.9)	##	##

* Number of nests; one egg from each nest unless otherwise noted.
§ Based on oven-dry weight of egg contents. Figures in parentheses represent range of values.
† With respect to the kestrel specimens collectively, there were: one egg from 1 nest, two from 19, four from 1 and five from 1. See Lincer (1972, 1975) for more detailed data on the kestrel.
‡ Number of eggs from one nest.
Substance not analyzed for.

The factors responsible for the disparities noted are potentially quite numerous. However, the two most important variables are probably the trophic levels of the species preyed upon and where the predator spent its non-breeding season (Cade et al., 1971; Seidensticker and Reynolds, 1971; Lincer and Sherburne, 1974). For instance, pellet analyses indicated that both the red-tailed hawk and great horned owl preyed primarily on the meadow vole *(Microtus pennsylvanicus)* in the Cayuga Lake basin. However, the owls preyed heavily on icterids in at least part of the study area (R. J. Clark, unpublished). Meadow voles in this basin contained an average of 0.03 ppm DDE, based on oven-dry weight, and a red squirrel *(Tamiasciurus hudsonicus)*, another common prey species, contained the same amount. Since immature icterids (chiefly blackbirds) and other marsh birds contained levels of DDE approximately 15 times greater than those of the microtines (Lincer and Sherburne, 1974), the differential in residue levels between red-tailed hawks and great horned owls may be partially explained by differences in prey preference.

It is likely that additional variation in residue levels in eggs is due to differential pesticide metabolism and/or different migrational habits of the two species. Unfortunately, little is known about comparative pesticide metabolism by raptors. Red-tailed hawks from this part of their range migrate extensively, while great horned owls in this area are non-migratory (Hager, 1957).

Among other diurnal birds of prey, the eggs of the Cooper's hawk contained, by far, the highest DDE residues. A single infertile egg, collected in nearby Pennsylvania during 1970, contained similarly high DDE residues (i.e., 58.8 ppm) based on oven-dry weight (Snyder et al., 1973). Since Cooper's hawks frequently feed on birds, it is tempting to suggest this prey preference as an explanation, and, in fact, comparisons within the genus *Accipiter* indicate that dietary preference for birds can contribute to significant differences in organochlorine accumulation (Snyder et al., 1973). However, although breeding red-shouldered hawks had all but disappeared from the Cayuga Lake basin, data for the one egg analyzed suggest that other factors were of greater significance and that organochlorines were probably not the primary agent responsible. On the other hand, this one (addled) egg was somewhat less than a "ramdom sample" and it revealed nothing about the residues in the eggs produced by females that no longer bred there. Nor is anything known about the comparative sensitivity of the red-shouldered hawk (vs. other raptorial species) to the eggshell-thinning effect of DDE. The low residue associated with the almost 6 per cent decrease in eggshell thickness noted in Table 2 suggests that this species may be quite sensitive to DDE, and Henny (1972) has reported a reduced reproductive success for this species in the Northeast.

Comparison of the shell thicknesses of the eggs collected for this study with museum data for eggs collected prior to the extensive use of DDT as given by Anderson and Hickey (1972) indicates that the buteos (i.e., red-tailed, broad-winged and red-shouldered hawks) had suffered the least change in the degree of eggshell thinning (Table 2). In these records,

Table 2. Shell Thickness of Raptor Eggs From the Cayuga Lake Basin in 1970-1972 Compared With Data From Various Areas For Earlier Periods

Species	Year	Number	Shell thickness	
			Ratcliffe's Index (see text)	Difference* (per cent)
Red-tailed hawk	1971	4	2.30 ± 0.19	+ 0.44
Red-shouldered hawk	1972	1	1.79	— 5.79
Broad-winged hawk	1971	1	1.77	+ 4.12§
Cooper's hawk	1971	2	1.49 ± 0.22	—19.02
American kestrel	1970-1972	34	0.95†	—10.00
Great horned owl	1972	3	1.69 ± 0.17	— 9.63§
Screech owl	1971	3	1.17 ± 0.07	‡

* Change in relation to years prior to extensive use of DDT. Data for earlier period taken from Anderson and Hickey (1972) and apply to years before 1947, except those for the great horned owl which represent the years 1954-1968.

§ Value may not be comparable to others since data for the earlier period were derived from potentially different range, i.e., interior North America for the broad-winged hawk and Ontario, Canada, for the great horned owl.

† See Lincer (1975) for details on within- and between-year variation.

‡ Values for Ratcliffe's Index were not available for comparable screech owl eggs for the pre-DDT period. However, compared with data for the actual thickness of 37 eggs collected in nearby parts of Pennsylvania during this time (Klass and Swineford, 1976), there was a 7.8 per cent decrease in eggshell thickness for screech owl eggs in the Cayuga Lake basin.

the great horned owl and American kestrel lay about midway between the extremes, exhibiting a 10 per cent decrease in eggshell thickness, while at the upper end the decrease for the Cooper's hawk was 19 per cent. The situation may be critical for the Cooper's hawk, since no North American raptorial population exhibiting a decrease in shell thickness of 18 per cent or more has been able to remain stable and self-perpetuating (Lincer, 1975).

CONCLUSIONS

There is no doubt that eggshell thinning in raptors and consequent reproductive failure are associated with pesticide contamination (Ratcliffe, 1967, 1970; Hickey, 1969; Berger et al., 1970; Cade and Fyfe, 1970; Cade et al., 1971; Lincer, 1975). Experimental studies have also elucidated the cause-and-effect relationship between dietary DDE and eggshell thinning in raptors (Wiemeyer and Porter, 1970; McLane and Hall, 1972; Lincer, 1972, 1975). Therefore, it is important to learn more about: (1) the reproductive and population status of the raptors, especially those like the

bald eagle, osprey, peregrine falcon, red-shouldered hawk, Cooper's hawk and great horned owl that produce highly-contaminated eggs and/or whose populations have drastically declined; (2) the comparative reproductive sensitivities of various birds of prey to human disturbance and persistent contaminants; and (3) the relative importance and roles played by genetic differences, prey preference and migrational behavior in determining residue accumulation, eggshell thinning and reproductive failure.

As man continues to dominate the environment to an ever increasing degree, raptors are subjected to increasing stress. Because their food source is scarce, in relation to that of animals at lower trophic levels, they require fairly large territories, making them vulnerable to changes in land use and the prejudices of man. Because of biological magnification, their position at the uppermost trophic levels makes them especially important as indicators of the quality of not only their own environment, but man's also. The "bottom line" is that the same factors which make them especially valuable as indicators also make them extremely susceptible to population stress when man adversely affects their environment.

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GROWTH CHANGES IN A POPULATION OF WHITEFISH IN LAKE ERIE[1]

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ABSTRACT

Experimental data collected from whitefish in the Pennsylvania waters of Lake Erie from 1971 to 1974 were used to describe the population since its drastic decline after the late 1940's. Growth was calculated and compared with that of the whitefish population of the late 1920's when the stocks were considered abundant. Several body-scale functions were tested for best fit, and the functional geometric mean regression (Ricker, 1973) permitted the closest fit to empirical data for mean length. Calculated growth curves for both periods were transformed to Walford regression lines, and the indicated lower rate of growth in recent years was deemed significant. A significant increase in weight per unit of length between the two periods was indicated by length-weight regressions (log transformations). Probable explanations for these changes are discussed, focusing primarily on climatology, the trophic state of Lake Erie and the zoogeography and abundance of whitefish.

Prior to 1950, the population of whitefish *(Coregonus clupeaformis)* in Lake Erie yielded an annual commercial harvest that ranged from a few thousand to 7 million pounds. Although production varied due to conspicuous variations in cohort size, whitefish were considered abundant until their precipitous decline after the late 1940's. The species still persists in this lake, but, for the most part, catches in experimental gear are low and considered as incidental encounters.

An examination of the biology of the present whitefish population in Pennsylvania waters was prompted by the persistence of a remnant population in the face of Lake Erie's environmental deterioration since the late 1940's. Limited data on whitefish in Lake Erie, procured since 1971, offered an opportunity to study their growth, the first study since that in 1930 reported by Van Oosten and Hile (1947).

The 183 whitefish examined were collected from 1971 to 1974, generally between June and October. They were taken with experimental gill nets and trawls over traditional fishing grounds directly off Erie (Pa.) at depths of 17 to 22 meters. Age groups I through XII were represented.

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[1] William Shepherd and Stephen Mooradian of the New York State Department of Environmental Conservation and Mercer Patriarche of the Michigan Department of Natural Resources reviewed the manuscript. It is published here because the findings have applicability to New York waters.

The fish were weighed and measured fresh, except for a few that were frozen and examined a short period after capture. Scales were removed from above the lateral line at a point below the dorsal fin insertion. Several scales were taken from each fish; three to six of these were examined for age determination, and one was measured for growth study. Scale radius, the maximum distance from the focus to the anterior margin, was measured on a magnified image (X25) of the scale and used in deriving body-scale proportions and back-calculating length.

BODY-SCALE RELATIONSHIP

The relationship between fish length and scale radius was linear for the sample data used (sexes combined) for growth calculations ($r = 0.936$, d.f. = 58). The data cited by Van Oosten (1939) for whitefish in Lake Huron showed a constant ratio of fish length and scale diameter, although, in their paper on whitefish in Lake Erie, Van Oosten and Hile (1947) did not indicate the nature of the body-scale relationship. A study of a slow-growing population of whitefish in Munising Bay in Lake Superior (Edsall, 1960) demonstrated that a correction factor was appropriate, but the body-scale data indicated a linear fit. Other studies of coregonids, cited by Edsall, also included the use of a linear body-scale relationship for growth calculations.

Because of the small number of fish available for the present study, the author was aware of the error associated with the linear body-scale relationship and considered the possibility that other functions might yield a better fit. Hile (1970) pointed out, in a review of body-scale relationships, that non-linear functions have sometimes proven to be adequate. Carlander (1945) demonstrated that a third-degree polynomial described the relationship of body length and scale radius accurately for a walleye population in Minnesota. A sigmoid curve was used by Eschmeyer (1950) to describe the body-scale relationship of a walleye population in Michigan. Chugunova (1959) also demonstrated the possibility of curvilinear functions for other species.

A second-degree polynomial, $L = a + bS + cS^2$, was developed from the same data used for calculating linear fit. Examination of the standard errors of deviation for the linear and polynomial regressions (46.5 and 45.7 millimeters, respectively) of scale radius against total length failed to show that the curvilinear fit was significantly better. A plot of the data also suggested that a third-degree polynomial fit was not warranted.

The relationship between magnified scale radii and total body lengths from empirical observations was compared with the results from calculations by linear and polynomial functions for the same specimens (Table 1.) Neither function offered satisfactory approximations of the empirical mean lengths for given scale radii.

Ricker (1973) proposed the use of the geometric mean regression as the best estimator available for short series of data where large or moderate variability exists — either inherent in the material or from its mensuration. Where only a portion of the total range of data is available in a sample from an "open-ended" distribution, a predictive regression tends toward an increase in magnitude as the range of variates increases. Ricker's functional geometric mean regression corrects this problem to some extent. Also, if any morphological significance can be given to the intercept value, i.e., length at initial scale formation, the value obtained by using the the geometric mean function appears to be the most realistic estimate. Therefore, this regression was employed for back-calculations with respect to whitefish.

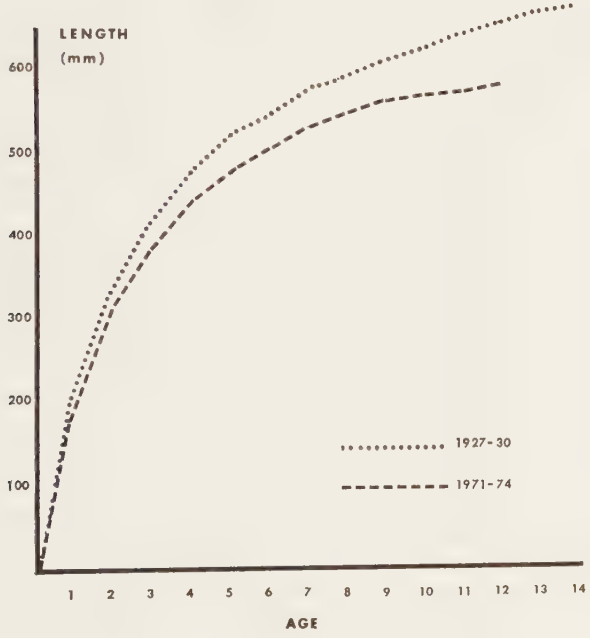

Figure 1. Back-calculated growth curves for whitefish in Lake Erie during the periods 1927-1930 and 1971-1974.

Table 1. Relationship Between Scale Radius and Total Length, As Determined By Observation and By Three Body-Scale Functions, For Whitefish Taken in Lake Erie During Period 1971-1974*

Item	Mean scale radius (X25)									
	27.0	50.2	69.2	91.3	111.1	129.4	150.1	169.5	187.7	207.3
Observed mean length	120	191	240	298	349	397	451	501	549	600
Calculated mean length										
Linear function§	144	203	251	308	358	405	457	507	553	603
Linear function†	122	186	237	297	351	401	457	510	560	613
Polynomial function‡	106	184	245	311	367	416	467	512	551	590

*All data in millimeters.

§Length = 74.9258 + 2.5477S (predictive regression).

†Length = 48.9917 + 2.7214S (functional regression).

‡Length = 8.9083 + 3.7143S − 0.0044S^2.

Table 2. Growth, As Indicated By Back-calculation of Total Length, For Whitefish Taken in Lake Erie During Period 1971-1974*

Age group	Number	Mean total length (millimeters) at annulus											
		1	2	3	4	5	6	7	8	9	10	11	12
I	9	177	..	..	..	..	..	..	..	..	..	..	..
II	12	174	301	..	..	..	..	..	..	..	..	..	..
III	27	177	306	383	..	..	..	..	..	..	..	..	..
IV	21	177	287	367	414	..	..	..	..	..	..	..	..
V	12	165	271	348	403	438	..	..	..	..	..	..	..
VI	19	181	321	349	439	472	495	..	..	..	..	..	..
VII	32	173	303	387	442	475	500	517	..	..	..	..	..
VIII	25	179	324	407	458	484	508	525	540	..	..	..	..
IX	16	182	325	420	466	494	515	533	549	562	..	..	..
X	2	190	307	378	433	494	519	539	560	577	597	..	..
XI	5	182	299	371	419	456	491	508	524	544	556	571	..
XII	3	176	320	392	428	462	481	507	528	542	552	558	570
Weighted mean		177	308	382	438	474	503	522	541	557	563	566	570
Standard deviation		4.5	18.8	22.3	19.7	15.6	8.4	8.0	8.6	10.4	18.0	6.7	..
Coefficient of variation		2.5	6.1	5.8	4.5	3.3	1.6	1.5	1.6	1.9	3.2	1.2	..
Increment		177	131	74	56	36	29	19	19	16	6	3	4

*Sexes combined.

GROWTH ESTIMATES

Growth curves representing the calculated lengths of whitefish for the periods 1927-1930 as reported by Van Oosten and Hile (1947) and 1971-1974 as obtained during the present study are shown in Figure 1. Related data for the 1971-1974 period are given in Table 2. To facilitate comparison, since in both periods a number of the fish collected were not sexed, growth was calculated after pooling the sexes for both mature and immature fish. Although females grew faster in the 1927-1930 period, Van Oosten and Hile considered the difference too small to bias intra-lake comparisons. Examination of recent whitefish growth rates showed that females exhibited a statistically significant ($P < 0.05$) difference only for the old fish and that pooling data would add little additional variability, even for the older age groups.

Comparison of growth for the two periods was undertaken after the growth curves were transformed to Walford lines (Figure 2). Based on an analysis of the two regressions by covariance, the slopes were not considered significantly different ($F = 2.59$, $P = 0.05$). Tests of the intercepts of these lines, however, proved highly significant ($F = 36.26$, $P = 0.01$) suggesting that the difference in growth for the two periods was probably real. The lower growth rate indicated for whitefish populations

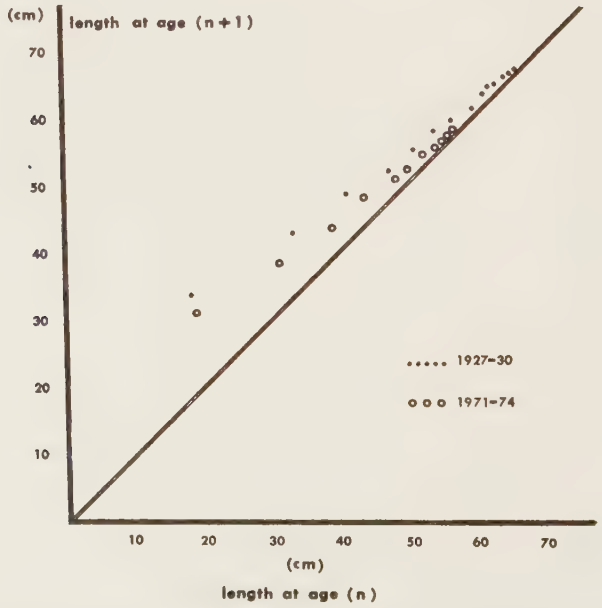

Figure 2. Walford growth regressions for whitefish in Lake Erie during the periods 1927-1930 and 1971-1974.

in the 1970's reflects slower growth among older age groups rather than sampling error. Despite the small number of older fish available for growth calculations, relative variation in length decreased (except at annulus 10) at older ages and virtually stabilized after age V.

LENGTH-WEIGHT RELATIONSHIP

Length-weight indices, also, are useful in describing differences within or between fish populations. Accordingly, the data given by Van Oosten and Hile (1947) and data from the recent collections of whitefish in Lake Erie were compared to detect possible shifts in the ponderal index of the species over the span of four decades. Only empirical measurements were used to construct the two length-weight curves. Because in the earlier study no differentiation was made with respect to sex, maturity, condition of gonads or locality within the lake, the data for 1971-1974 were treated in the same manner.

Logarithmic transformations of the data corrected both curves to linear form ($r = 0.983$ and 0.985, respectively). Covariance tests demonstrated that the regession coefficients were homogeneous ($P = 0.05$), but not the intercepts ($P < 0.001$). Contrary to the trend of decrease in linear growth, latter-day whitefish weighed more for a given length than whitefish of 40 years ago. Van Oosten (1937), studying another coregonid, the shortjaw *(Coregonus zenithicus)*[2], in Lake Superior, discovered that the slower-growing individuals in the population were heavier for a given length than faster-growing fish.

DISCUSSION

The recent work of Healey (1975) suggested that whitefish respond to fluctuations in population size by compensatory changes in growth rate, where population size is a function of the amount of fishing or rate of exploitation. In the case of unfished whitefish stocks, growth is generally related to the geographical range of the species, and the greatest lengths per age group are attained by populations in the central and more northern extentions of its range. Many coregonids are cold stenotherms, and the warmer, southern extensions of their ranges are considered marginal for growth and other biological functions (Hartman, 1973).

The observed decrease in the growth rate of whitefish in Lake Erie since the late 1920's might be explained by Healey's hypothesis. Prior to the mid-1940's, whitefish in this lake were abundant and heavily fished by the

[2]Whereas this species was formerly classified in the genus *Leucicthys*, as used by Van Oosten (1937), it is now considered a member of the genus *Coregonus*. Also, although Van Oosten used the name "longjaw", this species is now designated the shortjaw cisco.

Table 3. Growth of Whitefish in Various Populations in North America

Locality and population	Calculated mean total length (millimeters) at annulus									
	1	2	3	4	5	6	7	8	9	10
Great Lakes										
Lake Michigan, northern										
Big Bay De Noc (Roelofs, 1958)	143	239	350	455	..	..	..	..	..	..
Big Bay De Noc (Patriarche and Bails, 1974)	201	318	401	472	523	597	627	..	..	.
Lake Superior										
Whitefish Bay (Patriarche and Bails, 1974)	..	..	419	470	521	584	615	678	..	..
Southern shore (Patriarche and Bails, 1974)	231	356	417	462	478	486	467	470	528	622
Lake Huron										
Oscoda population (Patriarche and Bails, 1974)	..	356	478	551	597	643	673	688	..	..
Detour population (Patriarche and Bails, 1974)	..	..	..	394	460	500	536	566	..	..
Lake Erie										
Present study	177	308	382	438	474	503	522	541	557	563
Northwest Territories (Canada)										
Great Bear Lake (Healey, 1975)	..	..	284	312	327	418	460	509	534	552
MacEwan Lake (Healey, 1975)	..	..	..	474	521	564	604	624	653	668
Lake Hottah (Healey, 1975)	144	196	262	317	331	413	458	486	517	539
Lake Champlain										
Northern (Carlander, 1969)	140	246	330	399	442	475	500	521	541	554
Southern (Carlander, 1969)	135	267	363	429	465	493	513	528	541	559
Montana										
Streams (Peters, 1969)	99	198	290	333	371	..	..	..	..	..
Lakes (Peters, 1964)	178	277	356	..	..	..	..	..	..	..
Maine (Everhart, 1958)	..	262	318	330	340	358	384	399	421	414
Minnesota (Eddy and Carlander, 1942)	104	168	254	310	353	376	417	437	486	538

TABLE 3. (Continued)

Locality and population	Calculated mean total length (millimeters) at annulus									
	11	12	13	14	15	16	17	18	19	20
Great Lakes										
Lake Michigan, northern										
Big Bay De Noc (Roelofs, 1958)	..	..	..	..	..	..	..	..	..	..
Big Bay De Noc (Patriarche and Bails, 1974)	..	..	..	..	..	..	..	..	..	..
Lake Superior										
Whitefish Bay (Patriarche and Bails, 1974)	..	..	..	..	..	..	..	..	..	..
Southern shore (Patriarche and Bails, 1974)	..	..	..	..	..	..	..	..	..	..
Lake Huron										
Oscoda population (Patriarche and Bails, 1974)	..	..	..	..	..	..	..	..	..	..
Detour population (Patriarche and Bails, 1974)	..	..	..	..	..	..	..	..	..	..
Lake Erie										
Present study	566	570	..	..	..	..	..	..	..	..
Northwest Territories (Canada)										
Great Bear Lake (Healey, 1975)	470	591	617	628	648	701	711	768	768	796
MacEwan Lake (Healey, 1975)	583	..	..	..	..	..	..	..	..	..
Lake Hottah (Healey, 1975)	620	559	561	564	601	601	620	628	..	..
Lake Champlain										
Northern (Carlander, 1969)	572	584	594	607	615	625	635	..	..	..
Southern (Carlander, 1969)	572	582	589	599	607	615	612	..	..	..
Montana										
Streams (Peters 1964)	..	..	..	..	..	..	..	..	..	..
Lakes (Peters, 1964)	..	..	..	..	..	..	..	..	..	..
Maine (Everhart, 1958)	..	..	..	..	..	..	..	..	..	..
Minnesota (Eddy and Carlander, 1942)	..	..	..	..	..	..	..	..	..	..

commercial industry. As postulated by Healey (1975), the population responded to the fishing pressure by exhibiting growth that approached the apparent biological maximum for the species. Subsequent to the collapse of the population and the fishery after 1947, there should have been a gradual decrease in the growth rate as the population was rebuilding, before fishing became profitable again. However, neither the population nor the fishery ever recovered. The present slower rate of growth is apparently related to factors other than abundance. Since Lake Erie is at the southernmost limit of the whitefish's native range, the lake habitat is probably marginal for the species, and the deterioration of the last two decades has adversely affected growth.

Because of the deterioration since 1950 in the oxygen regime of the hypolimnion of central Lake Erie, the coregonids have had to abandon this summer refuge. Lately, the summer distribution of whitefish has been restricted to the lake's eastern basin where oxygen conditions are more acceptable. This change in habitat may not be entirely favorable and may be a cause for decrease in growth rate.

There is other evidence that supports the marginal-habitat hypothesis. It is manifested in effects other than growth which have altered or disturbed the biology of the species. A warming trend for Lake Erie's waters has been observed since the 1920's. While studying the history of variations in year-class strength among whitefish populations in the lake, Lawler (1965) found a direct relationship between cohort size and water temperatures during the fall and spring. It is during the periods of fall spawning and spring incubation that climatic warming could affect the narrow, optimum range of water temperatures deemed necessary for initial survival and maximum year-class development.

Despite the decrease in growth rate, whitefish in Lake Erie constitute one of the faster growing populations of the species in North America (Table 3). Apparently, the deterioration of its habitat in this lake has moderately affected growth, but it has had a much more detrimental impact on reproduction and/or survival of young.

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AN INTENSIVE LAW ENFORCEMENT EFFORT TO ASSESS THE INCIDENCE OF ILLEGAL DEER HUNTING AND CONTROL DOGS RUNNING AT LARGE IN THE PERIPHERAL ADIRONDACKS[1]

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ABSTRACT

An intensive program of law enforcement was undertaken in the Town of Malone in Franklin County (N.Y.) as part of a study of means of encouraging the growth of the deer population in the peripheral Adirondacks. The primary objectives were to assess the extent and impact of illegal deer hunting and to control dogs running at large. Two special game protectors patrolled the 148.6 miles of roads in the 105-square-mile town almost daily from October 1968 to March 1974, and frequent patrols of a surrounding 2-mile-wide buffer zone were also made. They recorded 43 violations of the Fish and Wildlife Law with respect to hunting that warranted investigation, of which 28 involved deer. About half of those involving deer pertained to jacking and taking antlerless deer illegally, with jacking being the more frequent. Other information indicated substantial trafficking in illegal venison. Also among the cases investigated were 76 incidents of dogs at large on lands inhabited by deer. However, dog control was ineffective when enforced solely by the special game protectors, but when the assistance of the local police was obtained the number of dogs running at large was curtailed sharply. Although findings related to illegal deer hunting were meager, they tend to support the belief that such hunting is the chief factor limiting deer productivity in the peripheral Adirondacks.

The deer population in the peripheral Adirondacks is relatively sparse and has long been substantially below the carrying capacity of the range. Mortality from starvation is uncommon. Severinghaus and Free (1963) found that the legal take of deer would not account for the lack of increase and concluded that illegal hunting, especially the taking of does, was the chief limiting factor. In a later analysis of data from the peripheral section, Severinghaus and Eabry (1973) found that: in the towns

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A contribution of New York Federal Aid in Fish and Wildlife Restoration Project W-89-R. A number of people made special contributions to the study. The late Dwinal Kerst, regional conservation officer, provided insight and leadership during its formation and was a continuing inspiration to the personnel involved in law enforcement. The special game protectors, Stanley Stickles and Lyndon Raville, patrolled the study area and were the backbone of all field activities. Elmer Davies, senior wildlife technician, and William Plumb, laborer, conducted successful efforts to live trap domestic dogs running at large. David Harwood, a student at North Country Community College, assisted in a survey of all camps in the Town of Malone. Finally, officials of the Town of Malone should be recognized for their continued support throughout the study and special thanks are due Hayden Flurry, dog warden, who willingly worked with the law enforcement personnel on dog control.

where antlerless deer could be hunted under permit, documented losses accounted for 64 per cent of the estimated total loss; whereas, in towns where such hunting was not permitted, documented losses accounted for only 9 per cent of the estimated total loss. They implied that, in the latter case, the difference was largely due to illgeal hunting and concluded that "substantial increases [in the deer population] are possible if losses among does can be substantially reduced."

In 1968 a study of this possibility was begun using the Town of Malone in Franklin County (N.Y.) as the study area, and Jackson (1974) reported on the carrying capacity of the deer range there. Another phase of the study was to undertake an intensive program of law enforcement to assess the incidence of illegal deer hunting. It was carried on from October 1968 to March 1974 and also included efforts to control dogs running at large as well as to promote a better public attitude toward observance of the Fish and Wildlife Law. For this phase, the study area comprised the 105-square-mile Town of Malone plus a 2-mile-wide buffer zone surrounding it.

PROCEDURE

To carry on the law enforcement activities, two special game protectors were employed. Whereas environmental conservation officers over the State generally are assigned to patrol areas of 200 to 300 square miles, in the present study the two officers together patrolled 105 square miles (the buffer zone was not patrolled regularly), providing the most intensive such coverage outside Long Island and New York City. To insure that they understood the purpose of the study, the necessity for collecting accurate data and the need to communicate effectively with the public, the special protectors were given on-the-job training that included instruction in patrolling techniques, public relations and court procedure under the supervision of Environmental Conservation Officer H. F. White. They were also encouraged to read and thoroughly understand the Fish and Wildlife Law (Fish and Game Law prior to 1972) as it pertained to their responsibilities.

Patrol of Study Area

Law enforcement patrols by the special game protectors were a routine part of the study. The 148.6 miles of State, county and town roads in the Town of Malone (outside the village of Malone) were covered almost daily, and frequent patrols of the surrounding buffer zone were also made. This occupied about 90 per cent of the officers' time, except during the period between the close of deer season and the beginning of dog quarantine when surveys of wintering deer and deer trapping were carried on.

The primary purpose, locality and intensity of patrols varied with the season. In the early fall, overlooks, back roads and out-of-the-way fields were checked at night for jackers (persons illegally hunting deer at night with the aid of a jacklight). During the open deer season, hunters were checked and all hunting camps were periodically inspected for evidence of violations. The winter months were devoted almost exclusively to field surveys and deer trapping, although, when snow conditions developed that made deer especially vulnerable to harassment by dogs, efforts to apprehend such dogs became a major activity. Beginning in July and continuing through the deer season (which closed during the first week of December), salt licks were observed for evidence of poaching, and night patrols were made on secondary roads between dusk and 1:00 to 2:00 a.m. to check for evidence of hunting illegally at night. Although not directly related to the deer problem, fishermen and trappers encountered were also checked for compliance with the law.

Whenever one of the special game protectors encountered or received a formal complaint concerning a violation of the Fish and Wildlife Law, or a suspected violation, he made a personal investigation and recorded the circumstances on an "investigation report" form.[2] A separate form was completed for each incident, including the disposition of the case, i.e.: (1) no violation proven; (2) verbal warning given by the officer; (3) written warning ("T-9 form") issued by the officer; (4) violation existed and defendant agreed to civil compromise; (5) violation existed but defendant refused a civil compromise and requested a court trial. Where a civil compromise was agreed to, the special game protectors were empowered to assess the penalty since the fines for violations are specified in the Fish and Wildlife Law. Where the case went to court, that phase was handled by the supervising conservation officer. The forms covering the various incidents recorded were filed each month together with reports of other activities. These were reviewed by the supervising conservation officer and project biologists.

For the study as a whole, civil compromises and criminal proceedings were the most common courses of action for violations investigated. Actually, a progression existed. As the study continued, the special protectors became more familiar with law enforcement procedures and local residents grew more cognizant that the law was being enforced. Thus, in the early stages of the study, verbal and written warnings were often given on first offenses. During the last three years, warnings were given only in extenuating circumstances where the officer felt that the violator should

[2]The term "investigation" was used for incidents where the officer had first-hand knowledge of the violation or the person making the complaint would serve as a witness.

be given another chance. In 1972, also, a procedural change occurred in the justice court system that reduced several violations from criminal to non-criminal status. As a result, appearance tickets[3] were then issued for all violations, and trials by judge became more frequent.

In a number of instances illegal activities such as maintaining salt licks, poaching, taking deer illegally for "camp meat" and marketing venison illegally came to the attention of the officers but did not warrant investigation in the absence of a formal complaint or convicting evidence. Nevertheless, their occurrence was recognized as having an impact on the deer population in the Town of Malone, and the special game protectors noted the circumstances in their diaries together with names and addresses when available.

From July 1 to December 1, beginning in 1971, all cars encountered on secondary roads after dark were stopped and checked for the presence of guns and jacklights. The officers recorded the time and place, license number and make of car, number of occupants, presence and location of guns, presence of jacklights and any unusual circumstances.

Dog Control

During most of the year, dog incidents came to the attention of the special game protectors largely as the result of complaints. However, when the special dog quarantines[4] were imposed, dog control became a major duty of these officers and most violations were discovered on patrols, although many complaints were also received by telephone at the homes of the officers. If the situation warranted, an investigation was made and so recorded; otherwise, dog incidents were reported on a separate form giving the circumstances and related data.

During a quarantine, any dog running at large, unless under the immediate control of its owner, was considered in violation of the quarantine. In addition, outside the Malone village limits, any dog not on lands farmed or cultivated by its owner could, under Sections 11-0529 and 11-0923 of the Fish and Wildlife Law, be considered running at large on lands inhabited by deer and could be shot by the special game protectors.

Patrol hours varied, but emphasis was placed on early morning when violations most frequently occurred. The general procedure was for the

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[3]An appearance ticket, analogous to a traffic ticket, constituted an order to appear before a judge for settlement of the case.

[4]Deep snow, especially when accompanied by thin crusting, makes deer extremely vulnerable to harrassment by dogs running at large. Under the Agriculture and Markets Law, the Commissioner of Agriculture and Markets is authorized to declare a quarantine on dogs in a county or town for the protection of deer when requested to do so by the county or town officials and when the Commissioner of Environmental Conservation concurs.

officer on duty to patrol roads in his car from 6:00 to 8:00 a.m. and observe all houses, but farm houses in particular. Many people apparently kept their dogs in or tied at night but released them in the morning to exercise. When a dog was seen it was observed until it returned home, or, if it did not return promptly, an attempt was made to get near it by calling it. Dogs that would not come when called were observed for as much as 3 hours to see if they went home. If the same dog was encountered several times chasing deer, it was shot, but every effort was made to capture it first, with shooting being the last resort.

Whenever possible, the presence or absence of a dog license was noted. Dogs seized in violation of the quarantine were taken to the owner if they had a license and to the dog warden if they did not. When a dog was seized and returned to its owner, the owner was given a verbal or written warning in the first instance. If the dog was found at large a second time, a written warning was issued or an arrest made for violation of the law. In most cases of arrest, a civil compromise was allowed and the defendant was fined $17.50 (as stipulated by law for a first offense) for each dog involved. Greater fines were imposed for second and third offenses. If the defendant was belligerent or refused to pay the fine, a criminal action was instituted and he was called to trial before a judge.

Public Education

Considerable educational effort was necessary in order to gain public support for the study. Various forms of communication were used. Newspaper articles appeared periodically in the Malone Evening Telegram telling of project activities and progress being made. Radio spots were aired on the local station during the deer season asking hunters to report their taking of deer and during dog quarantines asking dog owners to confine their pets as well as asking citizens generally to report violations of the quarantines. Two public information flyers were circulated in the Town during the study, and exhibits describing the work were displayed at the Franklin County Fair (in the village of Malone) and later at the public high school and in store windows in the village. Speaking engagements were not solicited, but at least one project representative attended all meetings of the Malone Fish and Game Club and of the Franklin County Sportsmen's Federation. In addition, the officers from time to time gave talks to service and social organizations and at Paul Smiths College.

FINDINGS

The data were analyzed with respect to hunting and dog control, particularly in relation to deer. Violations for which investigations were made were analyzed separately from the other violations recorded.

VIOLATIONS INVESTIGATED

During the study, 120 violations of the Fish and Wildlife Law in relation to hunting and dog control were investigated as a result of first-hand observations by the two special game protectors or formal complaints received. Of these, 100 were in the Town of Malone (Table 1) and 20 were in the surrounding 2-mile-wide buffer zone (Table 2) that was also within the jurisdiction of the two officers but where most of the patrolling was done during the fall to apprehend deer jackers.

TABLE 1. VIOLATIONS OF THE FISH AND WILDLIFE LAW IN RELATION TO HUNTING AND DOG CONTROL IN THE TOWN OF MALONE THAT WERE INVESTIGATED, 1968-1974

Violation	Number of investigations	Number of convictions*	Fines and penalties
Hunting			
Involving deer			
Loaded gun in car	5	5	$ 75.00
Hunting big game without license	2	1	12.50
Jacking deer	5	1	100.00
Taking antlerless deer illegally	1	1	102.50
Possessing untagged deer	1	1	12.50
Involving other wildlife			
Hunting without license	8	6	177.50
Non-resident with resident license	1	1	25.00
Taking small game out of season	3	3	112.50
Sub-total	26	19	617.50
Dog control			
Dogs running at large on lands inhabited by deer	73	37	585.00
Being afield with dogs during big game season	1	0	..
Sub-total	74	37	585.00
Total	100	56	1,202.50

*Frequently more than one conviction resulted from an investigation; either two or more persons were involved or one person was charged with more than one violation.

Within the Town of Malone, the vast majority of the violations investigated (73) involved dogs running at large on lands inhabited by deer. Most of these occurred during the dog quarantines each year from 1970 to 1974 when special emphasis was placed on dog control, and half of them (37) resulted in convictions most of which were civil compromises.

TABLE 2. VIOLATIONS OF THE FISH AND WILDLIFE LAW IN RELATION TO HUNTING AND DOG CONTROL IN THE BUFFER ZONE SURROUNDING THE TOWN OF MALONE THAT WERE INVESTIGATED, 1968-1974

Violation	Number of investigations	Number of convictions*	Fines and penalties
Hunting			
Involving deer	4	4	$ 55.00
Loaded gun in car	7	8	762.50
Jacking deer	2	5	805.00
Taking antlerless deer illegally	1	1	50.00
Trespassing on posted land			
Involving other wildlife	3	2	37.50
Hunting without license			
Sub-total	17	20	1,710.00
Dog control			
Dogs running at large on lands inhabited by deer	3	0	
Total	20	20	1,710.00

*Frequently more than one conviction resulted from an investigation; either two or more person were involved or one person was charged with more than one violation.

The 14 investigations involving deer hunting occurred during the fall just prior to or during the hunting season and included two major convictions, one for jacking deer and the other for taking an antlerless deer without a permit during the deer season. There were 12 investigations of violations involving other wildlife, of which 10 led to convictions.

In the buffer zone, there were only three investigations of violations involving dogs running at large on lands inhabited by deer. Of the 17 hunting violations, 14 were deer related and produced convictions of 18 persons. Of interest is the fact that the amount of fines and penalties collected for deer related cases ($1,672.50) was more than five times that collected ($302.50) for such cases within the Town. The chief reason was that more deer existed in the buffer zone, particularly in the Deer River area, and deer jackers were attracted to this area more than to any part of the Town of Malone. Also, the penalties for deer jacking and taking antlerless deer illegally are much higher than those for the other violations encountered.

Purported violations of the Fish and Wildlife Law with respect to deer that did not warrant investigation, but for which sketchy or hearsay evidence existed, are summarized in Table 3. In most cases, the officers received the information after the violation had occurred, either by overhearing a conversation or through a tip from an informant. All this information was vague, and while certain facts were known no complete and validated history was available for any one case. Of the poaching

Table 3. Purported Violations of the Fish and Wildlife Law With Respect to Deer on the Study Area That Did Not Warrant Investigation

Year	Violation			
	Poaching	Camp meat	Active salt lick*	Marketing illegal venison
1968	3	1	1	§
1969	5	0	2	§
1970	3	1	3	§
1971	3	0	3	§
1972	1	0	1	§
1973	2	0	1	§
Total	17	2	7	§

*Numbers of salt licks not additive because some licks were used in more than one year.

§Although project personnel were aware that such activity was going on, no specific information could be obtained.

cases, six were reported as jacklighting at night, three as taking deer illegally during the daytime and four as taking antlerless deer illegally on drives during the open season. No specific information could be obtained on the marketing of venison, although it was rumored that illegal venison had been sold at local restaurants and was being marketed in Quebec and New York City. During the fall of 1968, "camp meat" was discovered and documented at several camps by the special game protectors.[5] After that, the taking of camp meat appeared to decline dramatically. Seven salt licks located on the study area were used by deer at one time or another during the study, while two others were checked periodically but appeared to be unused. Despite continued surveillance and despite evidence of human activity at these licks, no one was ever apprehended and no illegal hunting was observed or reported at them.

Results of the car checks made during the late summer, fall and early winter in 1972 and 1973 are summarized in Table 4. Data for 1971 were incomplete and therefore excluded. Guns were found in 78 of the 195 cars stopped by the special game protectors during the two years. Of the 148 guns present, 122 (82 per cent) were not cased, and 74 (50 per cent) were lying on the front seat. Only 11 guns were in car trunks, but trunks were not routinely checked since a search warrant would have been required. Guns were found in a high percentage of the cars stopped during October and November which is partly explained by the fact that the small game season opened on October 1 and the deer season on October 25. Jacklights were not found as frequently as guns. In the 17 instances where jacklights were found, five were during the closed season, five

[5]The role of camps in relation to deer hunting in the Town of Malone was discussed by Jackson (1975).

TABLE 4. PRESENCE OF GUNS AND JACKLIGHTS IN CARS ON THE STUDY AREA AS DERIVED FROM ROAD CHECKS (1972 and 1973 combined)

Item	July	August	September	October	November	Total
Number of cars stopped	34	41	33	40	47	195
Number of persons in cars	61	83	*	74	100	*
Number of cars with guns	0	6	6	24	42	78
Guns present						
Number	. .	7	6	37	98	148
Number cased	. .	0	0	11	15	26
Number not cased	. .	7	6	26	83	122
Location of guns						
Front seat	. .	4	3	20	47	74
Back seat	. .	0	2	13	44	59
Trunk	. .	1	0	3	7	11
Gun rack	. .	2	1	1	0	4
Number of jacklights	0	4	1	6	6	17

*Data incomplete.

during the small game season and seven during the deer season. In only one of the five cases during the closed season was a gun present — an unloaded 22 caliber rifle under the front seat. In all 12 of the remaining cases where jacklights were present, guns were also present in various locations in the car, and in each instance at least one gun was not cased thus constituting presumptive evidence of hunting deer or bear with the aid of such light. However, in no case was such hunting observed so that no violation could be proven.

DOG CONTROL

Control of domestic dog activity was emphasized throughout the study. The most intensive effort, which resulted in the majority of cases involving dogs, took place during the special quarantine imposed in Franklin County. Dog quarantines were in effect from March 15 to April 15 in 1970, from February 15 to May 15 in 1971, from March 10 to May 1 in 1972, from February 22 to May 15 in 1973 and from January 24 until after termination of the project on March 31 in 1974. This phase of the study was described in some detail by Jackson (1970b, 1971a, 1972a).

Over the study period, including both violations that warranted investigation and those that did not, 230 dog incidents involving 370 dogs and 12 incidents involving wild canids were recorded. The degree to which different breeds of dogs were encountered is given in Table 5. Mongrels (38 per cent) and hounds of all sorts (34 per cent) comprised nearly three-fourths of all the dogs involved in violations. German shepherds were third (15 per cent) and the remaining breeds comprised only 13 per cent of the total. These proportions were roughly the same each year.

TABLE 5. BREEDS OF DOGS INVOLVED IN DOG INCIDENTS REPORTED ON THE STUDY AREA

Breed	Number	Per cent
Mongrels	141	38.1
Hounds	126	34.1
German shepherd	55	14.9
Collie	9	2.4
Husky	9	2.4
Boxer	6	1.6
Terrier	2	0.5
German shorthair	2	0.5
Irish setter	2	0.5
English pointer	2	0.5
English setter	2	0.5
Labrador retriever	1	0.3
Wiemaraner	1	0.3
Cocker spaniel	1	0.3
Great dane	1	0.3
St. Bernard	1	0.3
Dachshound	1	0.3
Chow	1	0.3
Basenji	1	0.3
Unknown	6	1.6
Total	370	100.0

Of the 370 dogs involved in incidents, 93 were licensed, 116 were not licensed and in 161 instances the presence or absence of a license could not be determined (Table 6). In these undetermined cases, the dogs were

TABLE 6. PRESENCE OR ABSENCE OF LICENSE FOR DOGS CHECKED ON THE STUDY AREA

Period	Licensed	Unlicensed	Unknown	Total
October 1, 1969 - March 31, 1970	3	5	9	17
April 1, 1970 - March 31, 1971	36	53	88	177
April 1, 1971 - March 31, 1972	37	34	34	105
April 1, 1972 - March 31, 1973	9	9	16	34
April 1, 1973 - February 28, 1974	8	15	14	37
Total	93	116	161	370

either still at large or there was no identification on the dog and the owner failed to claim it within five days (the required holding period in New York State).

The dogs reported were encountered in a variety of situations (Table 7). The Town of Malone, exclusive of the Village, is considered deer

TABLE 7. ACTIVITIES OF DOGS IN INCIDENTS REPORTED ON THE STUDY AREA

Activity	Number	Per cent
At large on lands inhabited by deer*	211	91.9
Chasing other wildlife	10	4.3
Chasing domestic stock	6	2.6
Miscellaneous (not wildlife related)	3	1.2
Total	230	100.0

*Includes 32 (14.0 per cent) actually chasing deer and 14 (6.1 per cent) running deer in a deer wintering area.

habitat, and a dog at large in this area was in violation of the law if off the owner's property. Incidents of this sort (211) constituted 92 per cent of the total, including 32 where dogs were actually chasing deer and 14 where dogs were running deer in a deer wintering area. Of the remaining 19 incidents, which were not deer related, 10 involved other wildlife, most often snowshoe hares being run by dogs out of season.

The data for the two years when the winters were moderate to severe (1970-71 and 1971-72) were analyzed with respect to dogs running at large. Of the 175 such incidents recorded throughout the Town, 32 (18 per cent) involved the Brown Road area which was the only deer wintering area in the Town in which dog incidents occurred as well as the only such area that was used during all six years of the study. The wintering area covered about 3 square miles during those winters, or about 2 per cent of the land area in the Town. Of the 32 incidents, 22 involved dogs from outside the wintering area and 10 involved dogs that resided within it. For the dogs from outside the area, the distances they travelled ranged from 0.8 to 4.2 miles and averaged 2.2 miles, based on the straight-line distance from the owner's residence to the point on the Brown Road area where the dog was apprehended. These data revealed that dogs came from as far away as the Village of Malone (3.5 miles or more). Also, the special game protectors frequently picked up dogs coming out of the village before they became involved in chasing deer.

In the vast majority of cases (179), dogs in violation of the quarantine or Section 11-0923 of the Fish and Wildlife Law or otherwise causing a nuisance were reported and frequently picked up by the special game protectors before becoming a threat to deer or other animals. Of the 370 dogs reported, 164 were picked up, 34 returned home on their own, 17 were shot and 155 remained at large (Table 8). During the first three years of the study, the dogs picked up (109) were generally taken to the owner's homes, but as compliance with the law improved, the general

Table 8. Disposition of Dogs in Incidents Reported on the Study Area

Disposition	Number	Per cent
Remained at large	155	41.9
Taken home by special game protector	120	32.4
Taken to dog warden	40	10.8
Returned home on own	34	9.2
Shot	17	4.6
Taken to shelter of Society For Prevention of Cruelty to Animals	3	0.8
Turned over to village police	1	0.3
Total	370	100.0

practice was to take them to the dog warden. For the 34 dogs that were observed by the officers to return home, the owners were warned or fined.

Of the 370 dogs involved in the incidents recorded, 275 were in violation of one or more of the five quarantines in effect during the study (Table 9). Obviously, encountering this large number during the quaran-

TABLE 9. DOGS INVOLVED IN INCIDENTS DURING SPECIAL DOG QUARANTINES IN THE TOWN OF MALONE*

Year	Total days of quarantine	Number of dogs involved	Number of dogs per day
1970	31	119	3.8
1971	90	61	0.7
1972	52	70	1.3
1973	84	10	0.1
1974	94	15	0.2
Total	351	275	0.8

*In 1970, 1971 and 1972, the enforcing agents were the special game protectors and the dog warden; in 1973 and 1974 the village police also participated.

tine periods was the result of intensive enforcement during these critical periods for deer. The number of such incidents recorded per day during each quarantine was calculated to determine the effectiveness of the control measures. Effectiveness increased each year, but it took the cooperation of the village police in enforcing the quarantine within the Village of Malone to reduce the number of dogs at large to a tolerable level in 1973 and 1974.

Wild canids have been present in New York for a number of years, and recent information (Severinghaus, 1974) indicates that the present population in the Adirondack region represents the eastern coyote (*Canis latrans* var.). Twelve incidents involving these animals were recorded during the study, six of which occurred in the winter of 1973-74 suggesting an increase in their numbers. However, there was added interest in taking them during that winter as a result of a sharp increase in pelt prices. Hunters were using dogs to track them, and coyotes were seen in areas where they had not been reported previously. Consequently, the increased incidence may have been in part a result of population redistribution. Most of the observations occurred near the Brown Road deer wintering area and Lake Titus. At least three of these animals were known to have been in the Brown Road area during the winter of 1973-74. Detailed observations were generally lacking, but accounts of two incidents, including one where a deer was killed, were published (Jackson et al., 1973).

DISCUSSION

The number of violations that were investigated by the special game protectors was limited by the requisite that the officer have first-hand knowledge of the incident or that the person making the complaint be willing to serve as a witness. During the first year or so of the study, documentation of violations of the Fish and Wildlife Law was chiefly the result of on-the-spot investigation of incidents observed by the officers themselves. As the study progressed, violators became more cautious and the cooperation of private citizens in reporting violations became increasingly important. The degree of trust in the officers developed slowly, but, as time passed, they received more phone calls and witnesses became more willing to provide convicting testimony. The most difficult task of all was to obtain convicting evidence where a deer had been taken illegally. The practice of taking deer, especially does, out of season is apparently widespread and socially accepted in the peripheral Adirondacks. Neither laws nor supporting information from the Department have been convincing to most of the local people in this area. The turning point in gaining cooperation seems to come when the people realize that they are cheating themselves and that, unless they abide by the law, there are going to be fewer and fewer deer to go around. At this point people become willing to report neighbors, or at least unknown violators, when the law is broken.

Persistent violators resorted to devious tactics to avoid apprehension as the study progressed. To meet this, the times of patrols, patrol routes and whether the officers worked individually or as a team were varied. Law enforcement techniques including stakeouts, road blocks, checking cars at night and routine patrolling were employed as the situation dictated. If one method proved unproductive, another was tried. The special game protectors maintained close contact with regular conservation officers and the State Police. Troopers were occasionally asked to assist in investigating violations where vehicular and traffic laws were involved or where roadblocks were needed.

Although the number of instances of deer being taken illegally that were encountered and that warranted investigation was not great, it was evident to project personnel that several times that number were actually being taken and that conservation laws were being ignored by a large segment of the public. It was common practice to carry guns uncased and in the front seat of vehicles. Guns carried in this manner are readily accessible, and loaded clips or single shells can be inserted into the chamber in seconds. It was also clear that a substantial traffic in illegal venison was going on, although this was said to have been more common six to eight years earlier. However, the law enforcement tactics used in this study would not be likely to produce conclusive evidence of such violations.

While poaching and taking deer illegally for camp meat appeared to decline as the study progressed, it was difficult to tell whether this was in fact true or whether it merely reflected greater caution on the part of the violators. Quite likely, people who previously jacked deer in the Town of Malone shifted their activity to other localities that were not patrolled as heavily.

During the early part of the study it was postulated that a calculated dog population could be derived through use of the Lincoln Index, i.e., expanding the known population (all licensed dogs in the Town) by the ratio of licensed to unlicensed dogs handled during a quarantine. A number of biases influenced the results of this calculation, and the population figures varied widely. The number of licensed dogs edged slowly upward from 1,117 in 1970. The total population in any given year would have been something in excess of the licensed number but probably not more than double it as the proportion of unlicensed dogs handled indicated. This conclusion is based on the presumption that the unlicensed dogs were more likely to be at large since the owners tended to be less responsible than the owners of licensed dogs. Also, unlicensed dogs were recurrent violators and the same dog occurred more than once in the incidents recorded.

Emphasis in controlling dogs at large was on preventive measures rather than on shooting or trapping. Where possible, dogs were picked up by the officer, although in some cases dogs found chasing deer were shot and several other dogs remained at large or returned home on their own. The preventive approach required more initial patrolling and public contact, but it was deemed more effective than the traditional law enforcement approach of shooting dogs after they are found actually chasing deer. Dogs were successfully trapped, but this method was considered effective only under special circumstances and was not deemed practical in the Town of Malone (Jackson and Davies, 1973). It is felt that, as administered, the approach used resulted in fewer public relations problems and helped develop a respect for dog laws among the people of Malone.

Some positive results were obtained from the dog control program. Persistent and rigorous enforcement of the dog quarantines by the special game protectors reduced the number of dogs running at large in the second and third years of the quarantines. However, it was realized early in the study that cooperation of the local law enforcement officials would be necessary to assure continuation of effective dog control after the project was terminated, since control measures would then be their responsibility. During the early years of the study, the mayor of Malone and the town board were approached on several occasions, both in person and by mail. Later an analysis of the dog problem in the Town was

prepared (Jackson, 1972c) and submitted to the town board. At first, the local officials were reluctant to act, but increasing pressure from the public, including nuisance complaints and the need for a dog pound, had a positive effect. Once the village police began enforcing the quarantine, the number of dogs encountered outside the village limits dropped dramatically, and there can be little doubt that this had a beneficial effect on the deer population. Dog owners in rural sections of the Town became conditioned to effective enforcement. But, when the study was terminated, enforcement devolved upon the dog warden, local police and one environmental conservation officer for whom this area was only part of his assigned territory. It seems clear that, without the cooperation of local officials, the efforts of a single conservation officer would have little effect on free-running dogs.

At the outset of the study there was considerable concern over the role of public education. Could law enforcement, by itself, produce a favorable attitude toward conservation laws that would result in minimizing the illegal taking of deer? There seemed to be no feasible way of separating law enforcement and education, since public support for the new program was needed and the enforcement officers would require public cooperation to learn of law violations. Therefore, education, or more appropriately public information, was incorporated to the extent considered necessary to obtain this cooperation. It is felt that it achieved its purpose, even though the degree to which the enforcement program decreased the illegal taking of deer could not be determined. On the other hand, a similar amount of educational effort would seldom be made within the jurisdiction of a regular environmental conservation officer.

In conclusion, because of the generally clandestine nature of illegal hunting, this effort, as carried on through overt law enforcement by temporary personnel, to determine the number of deer actually killed illegally in the Town of Malone was not successful. A program of this sort would probably be more effective if carried on by regular conservation officers who would not be faced with remaining in the community at the termination of the project. Also, undercover operations might provide evidence on which to convict some violators who otherwise would not be apprehended, as well as to break organized rings trafficking in venison illegally. Nevertheless, the findings tend to support the belief that illegal hunting is the chief factor limiting deer productivity in the peripheral Adirondacks. However, it appears that the only way to arrive at a reasonable assessment of the illegal kill is to elminate losses from other causes in a life equation based on population statistics for the region. Analyses of this sort and documentation of the other losses involved have been reported by Free

and Jackson (1969), Jackson (1969, 1970a, 1971b, 1972b, 1973), and Jackson and Sarbello (1974).

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RUFFED GROUSE AND SONGBIRD FORAGING RESPONSE ON SMALL SPRING BURNS[1]

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ABSTRACT

In the first 30 days following prescribed fires, ruffed grouse and a variety of small birds showed a marked preference for burned areas. Insects made up a greater proportion of the diet of adult ruffed grouse in this study than in any previously reported. Droppings from grouse foraging on recently burned areas indicated a distinctly higher intake of insects than did grouse droppings from unburned (control) areas. Pit-fall traps captured significantly higher number of ground insects in the burned areas than in the control areas.

There are very few references in the literature to the early responses of foraging birds to fire in their habitats. In a thorough review of the effects of fire on birds and mammals, Bendell (1974) covered a wide range of reports on the early reactions of wildlife to fire, but none of these references described immediate responses of birds to improved opportunities following wild or prescribed fire. Edwards and Ellis (1969) reported on the immediate, positive responses of mourning doves *(Zenaida macroura),* bobwhites *(Colinus virginianus)* and woodcock *(Philohela minor)* to a small, open-field burn in Illinois. Although not able to identify the activities of these birds, they concluded that bobwhites, in particular, responded very quickly to burning and newly burned fields. Hurst (1972), using adopted bobwhite young, demonstrated the relationship be-

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tween February burns, insect biomass and foraging by quail broods in habitats in the Southeast; however, his concern was not with immediate responses to fire, but rather with changes in productivity during the subsequent summer.

The purpose of the present study was to investigate the short-term responses of ruffed grouse (*Bonasa umbellus*) and other birds to small burned areas within their home ranges in early spring. It is part of a long-term investigation of fire ecology and management in New York State.

METHODS

Seven old fields in the vicinity of Ithaca (N.Y.) were selected for treatment with prescribed fire. These fields varied in size from 0.4 to 5.0 hectares and were covered with medium-textured silt loams derived from low-lime glacial till. Typically, a fragipan layer had developed at a depth of 30 to 45 centimeters, causing poor internal drainage (Neeley, 1965). At the time of burning, these fields were covered with a predominantly herbaceous plant community typical of old-field succession in New York. Two of the sites (airport plots) were located east of Ithaca and had reverted from cropland and pasture within the previous 20 years (Figure 1). Plant cover on the airport sites was an approximately equal mixture

Figure 1. Experimental burn in progress on old-field site east of Ithaca (airport plots); note abundance of grass and forb surface fuel.

of grasses (*Poa, Agropyron, Phleum* and *Dactylis* spp.) and herbaceous dicots (*Solidago, Aster, Daucus, Hieracium* and *Rumex* spp.). Shrubs were scattered throughout these fields but did not exceed 20 per cent of the ground cover. Arrowwood *(Viburnum dentatum)* was one of the most abundant shrubs, followed by nannyberry *(V. lentago)* and gray dogwood *(Cornus racemosa)*. Willow (*Salix* spp.) and aspen *(Populus tremuloides)* were the most common tree species encountered; however, they were very scattered in distribution and occupied less than 2 per cent of the total ground cover. Fuel on these sites was provided by 300-400 grams per square meter of herbaceous standing crop at the end of the growing season. Additional fuel was provided by 300-400 grams per square meter of detritus on unburned sites (Baker, 1968; Euler, 1974).

The other five sites were on the Connecticut Hill Wildlife Management Area and were in a more advanced stage of secondary succession following their earlier reversion from agriculture circa 1930 (Figure 2). This area was described by Bump et al. (1947:695), and the amount of forest closure following 20 years of reversion was reported in a later paper (Bump, 1950). The soils of the Connecticut Hill sites were of similar origin and character to those of the airport plots, but they were better drained

Figure 2. Surface fuels on the Connecticut Hill Wildlife Management Area were often thin enough to allow creation of a firebreak without the use of mechanical equipment.

(because of steeper slopes) although they also suffered from greater erosion. The higher elevation of these sites (580 vs. 340 meters) also contributed to a shorter growing season and a delayed phenology. A few were still open-field habitats with a mixture of herbaceous cover predominating. Shrubs and sapling-stage trees were scattered throughout the fields selected for study, but they occupied less than 5 per cent of the total ground cover. Red maple *(Acer rubrum)* stems up to 6 centimeters in diameter were the most abundant saplings. The weight of standing crops of herbaceous growth on Connecticut Hill was less than half that on the airport plots (Euler, 1974).

Each of the seven prescribed burn sites was divided into two parts as nearly identical as possible. The halves were assigned to treatment or control at random. The treatment half was burned during the last two weeks of April or the first week of May. Burn 3 on Connecticut Hill and Airport 1971 were burned in 1971. The other plots were burned in 1972.

Periodic counts of fecal droppings from ruffed grouse were used as an index of activity on the burned and control areas. This provided a better estimate of grouse activity than did flushing counts since the experimental units were relatively small. A 2-meter-wide strip on the inside perimeter of each plot was searched, and all grouse droppings were counted and collected. To test for possible differences in visability of droppings on the burned versus unburned plots, a known number (100) of droppings were scattered at random over a strip that had just been carefully searched, and a correction factor was developed following two tests by each of two field assistants.

Songbird activity was measured by counting all small birds foraging on the burned and control areas. Each count was made while the senior author walked slowly along the inside perimeter of the area. Ten minutes were allotted for each count; at each site, whether the first count was made on the burned area or on the control area was determined by coin toss.

To measure the effects of fire on the spring diet of ruffed grouse, droppings were collected from burned areas, drumming logs, and several nonburned areas similar in physiognomy to the burned areas but located at least 1,000 meters away. Based on data reported by Gullion (1972), this distance was sufficient to exclude droppings from birds that used the burned areas. These droppings were dried, crushed, weighed and immersed in a beaker of water for at least 30 minutes. The chitinous invertebrate parts that floated to the top were caught on filter paper, dried and weighed. The percentage of chitinous material in the droppings indicated the relative amounts of insect food in the diet.

Paired sets of pit-fall traps were used to examine the relationship between grouse and songbird foraging and arthropod abundance. The traps were made by sinking 12-ounce cans into the ground flush with the soil surface. A small hole provided drainage but did not permit macroscopic invertebrates to escape. At a given site, five traps were placed at 16-meter intervals in a straight line perpendicular to the fire lane and extending into the burned area, and five others were similarly placed in the control area. Forty traps were placed on four experimental sites. Terrestrial invertebrates that blundered into the traps provided an index to their activity, abundance and availability on each plot.

RESULTS

Project field assistants showed similar patterns of search bias that tended to underestimate the number of droppings on the control plots, the mean recovery values being 57 per cent for burned areas and 47 per cent for control areas. The data were corrected for this bias. Table 1 reflects the striking differences in grouse activity that were observed between the burned and control areas. Over-all, for the first 30 days following fire, the incidence of droppings on the burned areas was 15 times that on the control areas. This dramatic difference in use began to be evident within 48 hours after the burns were made.

Table 1. Distribution of Ruffed Grouse Fecal Droppings On Seven Burned and Control Areas During 30 Days Following Prescribed Fire §

Area	Size of burn (hectares)	Number of droppings per hectare †	
		Burned areas	Control areas
Connecticut Hill			
Burn 3	1.5	1,456	53
Burn 4A	0.5	1,158	106
Burn 4	0.4	842	0
Burn 5	2.7	491	150
Burn 6	2.6	175	0
Airport 71	0.9	580	21
Airport 72	5.0	754	43
Mean	1.9	779	53**

§ Based on 300 droppings found on strips 2 meters wide along the inside perimeter of each burned and control area.
† Extrapolated from densities in perimeter strips with correction for search bias.
** Difference between burned and control areas significant at 0.01 level.

Moreover, songbird counts (Table 2) showed a parallel pattern of strong preference for the newly burned areas, seven of nine species tallied being present in significantly larger numbers on the burned areas. There also were probably real differences for the chipping sparrow *(Spizella passerina)* and swamp sparrow *(Melospiza georgiana)*, although the low den-

TABLE 2. MEAN NUMBERS OF VARIOUS SPECIES OF SONGBIRDS COUNTED DURING 64 10-MINUTE OBSERVATION PERIODS ON SIX PAIRS OF BURNED AND UNBURNED (CONTROL) AREAS IN 1972

Species	Area		Value of *t*
	Burned	Control	
Common flicker *(Colaptes auratus)*	8.8	1.3	7.5 **
American robin *(Turdus americanus)*	35.2	8.3	12.4 **
Red-winged blackbird *(Agelaius phoeniceus)*	5.0	1.7	2.64 *
Brown-headed cowbird *(Molothrus ater)*	9.7	1.7	3.3 *
Dark-eyed junco *(Junco hyemalis)*	7.8	0.7	2.95 *
Chipping sparrow *(Spizella passerina)*	3.8	1.7	2.1 n.s.
Field sparrow *(Spizella pusilla)*	6.8	1.2	3.5 *
Swamp sparrow *(Melospiza georgiana)*	2.0	0.7	1.3 n.s.
Song sparrow *(Melospiza melodia)*	9.7	3.5	4.13 **
Total	88.8	20.8	5.6 **

** Difference significant at 0.01 level.
* Difference significant at 0.05 level.
n.s. Difference not significant at 0.05 level.

sities of these species and the relatively small size of the study plots made the counts inconclusive. The behavior of robins, chipping sparrows, song sparrows and other litter-surface foragers indicated that they were using visual cues to locate their prey. These birds moved over the charred experimental plots in a wandering zig-zag pattern, stopping short with outstretched neck at the end of a brief advance, then darting out to attack a prey item. Chipping sparrows would frequently mount small rocks or clods of burned sod as though attempting to gain a wider view of the surrounding mat of black detritus ash.

We were not able to observe grouse during their foraging activities. However, their droppings were distributed over the entire surface of the burned areas, suggesting that their foraging patterns were similar to those of the songbirds. Table 3 shows that the droppings of grouse foraging on

TABLE 3. PROPORTION OF INSECT PARTS IN RUFFED GROUSE FECAL DROPPINGS COLLECTED ON BURNED AND UNBURNED AREAS FROM APRIL 24 TO MAY 5 IN 1972 AND AT DRUMMING LOGS IN THE SPRING OF 1972

Place collected	Number examined	Total dry weight (grams)	Proportion of insect parts*
Burned area	13	4.3	18 ± 1.5**
Unburned area	12	3.7	tr.
Drumming log	11	7.4	tr.

* Mean percentage by weight.
** Difference between burned areas and other sites significant at 0.01 level.

the burned areas contained significantly larger amounts of arthropods than droppings collected on unburned areas. Attempts to identify invertebrate foods in the grouse droppings were not wholly successful. Wing covers from beetles (Coleoptera) and abdominal sclerites from ants (Formicidae) were readily identified, but enough unidentified fragments and appen-

dages remained to discourage further food habits analysis. An index of invertebrate availability on the plots is shown by the captures from 40 pit-fall traps (Table 4). More beetles and ants were captured on the burned areas than on the controls, but other arthropods were more or less equally abundant on both areas. The beetles were primarily from the families Carabidae and Staphylinidae.

Table 4. Invertebrates Captured in Pit-fall Traps During 1,680 Trap-hours On Burned and Control Areas Between April 24 and June 29 in 1972

Type of invertebrate	Number of individuals	
	Burned areas	Control areas
Carabidae	67*	32
Staphylinidae	21*	12
Other beetles	45*	30
Ants	223**	52
Crustaceans	200	203
Centipedes	47	26
Spiders	53	77

* Difference between burned and control areas significant at 0.05 level.
** Difference between burned and control areas significant at 0.01 level.

DISCUSSION

Although Bendell (1974: 109, 113, 119) implied that fire has little effect on wildlife populations, other workers have emphasized the intermediate or long-term benefits of small burns to ruffed grouse (Gullion, 1967; Sharp, 1970; Vogel, 1967). The present authors wish to point to the additional short-term effects that were apparent for the birds using the study plots described here. Ruffed grouse and songbirds were attracted to the burned sites in the first days following prescribed burning. The feeding behavior of songbirds and the occurrence of large quantities of insect parts in grouse droppings from these areas suggest that the birds sought and favored these sites as superior invertebrate foraging grounds.

Bump et al. (1947:221) and Stewart (1956) clearly demonstrated a sharp preference for invertebrates by ruffed grouse chicks, but there have been very few reports of heavy use of insect food by adult grouse. Bump et al. (1947:212) and Korschgen (1966) found no appreciable quantity of insects in the diets of ruffed grouse except for birds collected during periods of unusual insect abundance. The present findings suggest that adult grouse consume large quantities of insects in early spring if they are available.

On Connecticut Hill, female grouse typically begin laying during the last week of April. Most clutches are finished during the first week of May, and most broods hatch by June 1. Laying a clutch of eggs requires a considerable outlay of nutrients, including protein. For the domestic

hen, each egg contains an amount of protein equivalent to the total content of circulating plasma proteins in the blood (Sturkie, 1965:55). Female grouse must therefore, at some time in the preincubation period, obtain an adequate supply of protein to produce a viable clutch of eggs. Insects provide protein at higher concentrations than most plants and could be very important during this laying period. The droppings (predominantly from male birds) that were collected from drumming logs contained virtually no insects. This suggests that most of the droppings from the foraging areas (high insect content) were from female birds. Male grouse stay very close to their drumming logs during the breeding season and must find food nearby (Bump et al., 1947).

Three aspects of burned areas make them potential sources of insects or other arthropods in the early spring. First, the availability of surface-dwelling invertebrates is dramatically increased with the combustion of standing vegetation and surface litter. Second, increased soil temperature in the first few weeks following fire may increase invertebrate activity, making them more conspicuous to the predator. Baker (1968) found differences of more than 10° F. in soil temperatures on burned versus unburned plots during May and June; differences of this magnitude could have a profound effect on insect activity and availability. Last, a temporary increase in insect abundance may occur with the earlier appearance of overwintering adults as higher temperatures in the upper soil horizon stimulate early emergence.

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GENERAL NOTES

A LEAD DETECTION KIT FOR DETERMINING BULLET WOUNDS

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Bullet wounds, legally or illegally inflicted, are common causes of wildlife mortality. Frequently, environmental conservation officers, biologists and animal control agents must make field examinations of dead wildlife for evidence of injury by gunshot. Generally, it is impractical to do a thorough post mortem in the field. Even extensive dissection, such as of a deer in the possession of an archer but suspected of having been illegally killed with a firearm, can be difficult to carry out in the field, for legal as well as other reasons. Therefore, the Department's Division of Law Enforcement requested that a rapid test for presumptive evidence of lead be devised that would be suitable for field application. Accordingly, the lead detection kit described here was developed.

The test devised involves the fact that rhodizonic acid reacts with lead to yield a red to red-purple precipitate. Therefore, the kit developed contains sodium rhodizonate and distilled water for preparing rhodizonic acid, plus other items for making a test, including nitric acid for producing lead salts in suspect and control materials. The components of the kit and their uses in testing for lead are listed in Table 1.

Table 1. Chemicals and Materials Used in Lead Detection Kit

Item	Purpose
1. Disposable vinyl gloves	To keep hands uncontaminated
2. Gauze (4-inch pads)	To clean excess blood from wounds
3. Comb	To part hair or feathers while searching for wounds
4. Hand lens	To aid in finding bullet fragments in wounds, and in examining wounds
5. Sterile scalpels (disposable)	To cut skin from around suspect wounds
6. Dissecting forceps	To pick up tissue and/or fragments of metal from wounds
7. Magnet	To test shot; lead shot are not magnetic, but steel shot are
8. Filter paper (high grade, round, 125 millimeters in diameter)	To hold suspect lead material and known lead sample (control) during test
9. Lead shot (No. 6)	To serve as known lead sample in control test
10. Applicator sticks	To transfer lead shot from storage vials to filter paper for control test
11. Nitric acid (15 per cent) in dropper bottle	To apply to both suspect and control materials to form lead salts
12. Sodium rhodizonate*	To prepare fresh rhodizonic acid
13. Distilled water in container marked to indicate 5-milliliter levels	To prepare fresh rhodizonic acid
14. Wire laboratory spatula	Used only for measuring sodium rhodizonate

*In the tests and results reported here, the compound used was sodium rhodizonate (U 893) obtained from J. T. Baker Chemical Co., Phillipsburg, N.J.

An example of a lead detection kit.

Initial testing of the method was carried out on wildlife that had been killed by rifle shot by the public and, either following confiscation or because of possible disease, was submitted by conservation officers and wildlife biologists to the wildlife pathology unit. Included in these tests were red fox *(Vulpes fulva)*, coyote *(Canis latrans)*, gray squirrel *(Sciurus carolinensis)*, wild turkey *(Meleagris gallopavo)* and white-tailed deer *(Odocoileus virginianus)*. In addition, more than 200 other tests were made on road-killed white-tailed deer, black bear *(Ursus americanus)* and red fox. The majority of trials on road-killed animals involved shooting the carcasses with various firearms at ranges of 10 to 30 meters. An array of types and calibers of ammunition was tested, including 22 caliber long rifle (solid point and hollow point), 22 magnum (solid point, hollow point and full copper jacket), 222 caliber (50 grain), 6 mm (100 grain) and 30-06 (150 grain soft point). In 20 cases involving deer and bear, broadhead arrows were driven into 22 caliber bullet wounds, as might be done by individuals attempting to make a rifle kill appear to have been done by an arrow. Also, carcasses of ring-necked pheasant *(Phasianus colchicus)*, Canada goose *(Branta canadensis)*, white-tailed deer and black bear were shot with 16 gauge magnum shotgun shells containing No. 6 shot.

In all the wildlife specimens that had been shot by the public with rifles, evidence of lead was obtained from the wounds by the nitric acid and rhodizonic acid procedure. In the other tests, all the experimental entrance wounds made by 22 caliber ammunition gave positive evidence of lead, including the wounds through which broadhead arrows had been pushed. In the holes caused by larger-caliber weapons lead was also found, except in the case of a 30 caliber heavily jacketed bullet fired at close range. But wounds inflicted by lead shotgun pellets in ring-necked pheasants, Canada geese, white-tailed deer and black bears generally were negative when the skin about the wounds was tested.

Rhodizonic acid for use in this procedure is prepared by mixing approximately 20 milligrams of sodium rhodizonate into 10 milliliters of distilled water. In the tests reported here, the compound used was sodium rhodizonate (U 893) obtained from J. T. Baker Chemical Co. The solution should be a rich yellow-orange in color. However, in solution rhodizonic acid is unstable and breaks down in a few

hours. Therefore, the acid must be made up fresh just prior to each test. For field purposes, the required amount of sodium rhodizonate may be satisfactorily approximated as that which will be held on the outer ⅛ inch of the pointed end of the spatula.

Based on the experiments carried on, the following procedures were judged most effective for determining the presence of lead in wounds.

Control Tests

Each time a suspect material is tested, a control test should be made first. This will confirm that the chemicals are working properly on lead, and the red-purple color produced can be used for comparison with the color appearing in or about the suspect material when that is tested. A control test may be made as follows.

1. Place a lead shot on a clean filter paper.
2. Add two drops of 15 per cent nitric acid to the shot.
3. Wait 2 minutes and add several drops of rhodizonic acid. The reddish-purple color should show immediately, and it should be intense if the chemicals are in proper working order.

Testing Tissue From Wounds

Next to that encountered in bones and teeth, bullets and shot pellets meet the greatest resistance from skin, especially thick skin such as is found in deer and bear. The lead from a bullet can frequently be seen impregnated in the skin about the periphery of an entrance wound or about parts of exit wounds. To examine the skin about a suspect wound, proceed as follows.

1. Shave the hair with a scalpel, or pull the feathers, from around the circumference of the wound. Excess hair or feathers hold the acids and make the tests more difficult.
2. Remove a strip of skin (approximately 5 millimeters wide) from around the wound with a scalpel.
3. Blot off any blood with clean gauze or filter paper. Excess blood makes the test difficult to read.
4. Place the skin removed on a clean filter paper and add two drops of 15 per cent nitric acid to the tissue suspected of containing lead.
5. Wait 2 minutes and add one or two drops of rhodizonic acid. The development of a reddish-purple color on the filter paper and/or the tissue indicates the presence of lead.
6. If no color develops, add several more drops of rhodizonic acid and again watch for color developments. If no diagnostic color is seen, blot the bullet hole with a new piece of filter paper and apply the test to it. For a final check, two more drops of rhodizonic acid may be added to the blot. It was noted in several wounds made with large-caliber rifles that the skin was extremely bruised and the red-purple color could not be easily seen on the tissue. However, by blotting with a second piece of filter paper, a positive test was readily obtained.
7. If lead deposits are small, the color may be faint and fade rapidly from filter paper. However, heavy deposits of lead in tissue may remain reddish-purple for days.

Testing Fragments of Metal From Wounds

If fragments of metal can be found in a wound, but the bullet cannot be found, the chemical test for lead is ideal. The following procedure should be used.

1. Place the fragment or fragments of metal on a clean filter paper.
2. Add two drops of 15 per cent nitric acid to the metal.
3. Wait 2 minutes and add one drop of rhodizonic acid. The production of reddish-purple color indicates the presence of lead. If the color does not develop, add several more drops of rhodizonic acid. Lead fragments from bullets or slugs produce an intense reddish-purple color. Also, lead fragments are not magnetic.

Testing Shotgun Pellets

Although the results generally were negative when the wounds inflicted by shotgun pellets were tested with this technique, it may be desirable to test shotgun ammunition, especially in connection with the new regulations requiring steel shot for waterfowl hunting. The following methods might be used.

1. To check an unfired shotgun shell, run a small bar magnet over the plastic or cardboard case. Steel shot are magnetic, but lead shot are not. One can readily detect the attraction of the magnet for steel shot through the shell case.
2. A suspect pellet taken from an animal or shotgun shell can be tested in the same way as described for testing fragments of metal from wounds.
3. In addition, steel pellets are hard, while lead pellets are malleable.

DISCUSSION

According to Thompson (1966, pp. 587-589), lead ($PB++$) reacts with sodium rhodizonate in solution to form lead rhodizonate which at a neutral pH has the formula PbC_6O_6-$Pb(OH)_2 \cdot 5H_2O$ and is violet in color, and at pH 3 has the formula $2Pb\ (C_6O_6)$-$Pb(OH_2) \cdot H_2O$ and is scarlet red. With the low pH of 16 per cent nitric acid, as used here, a red-purple color is produced, and rarely some violet is seen.

Sodium rhodizonate forms colored precipitates with other metallic ions besides lead. However, none produces the red-purple color that is characteristic of lead. Those that react optimally with sodium rhodizonate at a neutral pH are bismuth (brown-red), cadmium (brown-red), copper (orange-red), mercury (brown-red), silver (black), thallium (dark brown), uranium oxide (brown) and zinc (brown-violet). Those metals that react at an acid pH (e.g., 3) are cadmium (brown-red), mercury (brown-red), silver (black), thallium (dark brown), tin (violet), and barium (red), as variously noted by Feigl (1958, p. 73), Thompson (1966) and Glater and Hernandez (1972). It is unlikely that these other metallic ions would create any problem in the use of this method for identifying lead in bullet wounds.

Use of the lead detection kit described here does not lessen the need for a thorough visual examination of suspect wounds by the field investigator. Rather, it should be used primarily as a tool for gathering supplemental data. A positive identification of lead is strong presumptive evidence that the wound involved was made by a lead missile. A negative finding, however, does not rule out the possibility that the wound was actually made by a lead projectile. The tissue tested may have been improperly selected for analysis or the concentration of residual lead may have been too small to detect. Therefore, the disposition of a legal case should not depend on the positive result of the lead test alone. Nevertheless, this procedure, together with the field examination of the wounds involved, can provide the evidence of probable cause needed for submitting animals suspected of having been shot to a wildlife pathologist or other expert for more definitive analysis.

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LEAD POISONING IN A WILD TURKEY

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On May 24, 1975, an adult female wild turkey *(Meleagris gallopavo)* was found dead in the Town of Veteran in Chemung County (N.Y.) and submitted to the Wildlife Pathology Unit for necropsy. Gross examination revealed the bird to be severely emaciated and to weigh only 2.9 kilograms, with greenish feces matted on the plumage about the vent. Necropsy showed a lack of fat, and atrophy of the skeltal muscles, liver, ovary and gizzard. The gall bladder was distended with bile. The proventriculus was impacted with maple and ash seeds, corn and small crab apples. The gizzard contained a few stones, four worn lead shot, one copper pellet of the type used in an air rifle, and maple and ash seeds. The horny lining of the gizzard was sloughing.

A smear of heart blood was stained with Giemsa stain. The blood morphology appeared normal and no basophilic stippling was found, although rare gametocytes of *Leucocytozoon smithi* were seen. Samples of breast muscle and liver tissue were submitted to WARF, Inc. for analyses of lead and were found to contain, respectively, 0.61 ppm and 17.3 ppm of lead (wet weight). The level present in the liver is within the range found in waterfowl exhibiting lead toxicosis caused by ingestion of birdshot (Locke et al., 1966; Locke and Bagley, 1967; Irwin, 1975).

This is an unusual case, since feeding wild turkeys would seldom encounter lead shot. However, on occasion wild turkeys might acquire lead poisoning from ingesting shot from skeet ranges or in the vicinity of wetlands that are heavily shot over for waterfowl.

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EVIDENCE OF BROWSING AS A GUIDE TO MAPPING WINTER DEER RANGE

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In recent years there has been an increase in the need for accurate maps with respect to the winter range of white-tailed deer *(Odocoileus virginianus)* in the Northeast. This has resulted from accelerated land development, requirements for environmental impact statements, requests for information from land-use planners in both the public and private sectors and the use of such maps in hearings concerning land use. The growing demand for land for residential development as well as commercial use continually threatens to usurp valuable segments of deer range. In order to judge the effect of such losses of habitat, it is important to know how vital they are in maintaining the deer population. Maps are needed that delineate the areas of deer range that must be held as indispensible to perpetuation of the species in a given territory. Because winter is the "weakest link" in the annual life cycle of deer in the Northeast, this essential habitat is part of the wintering grounds where a population tends to congregate from late fall until spring each year. In preparing such maps, standardization of field work and documentation of data have become important since wildlife biologists are being asked more and more to substantiate their observations.

For mapping purposes, past surveys in the northeastern states have relied heavily on observations of current or recent deer track and trail activity, and to some extent on direct observations of the animals themselves. Both ground cruises and aerial surveys have been employed. Evidence of deer browsing on woody vegetation has served to supplement other ground observations. The various procedures used have been described in reports of the Federal Aid in Fish and Wildlife Restoration projects in these states.

There are a number of inherent disadvantages to these procedures. Field work cannot be started until the deer have actually concentrated on their winter range. During winters that are relatively mild, in respect to ease of deer travel, conditions suitable for mapping may never develop. Even when they do, the observer may have to base his conclusions on evidence of activity that covers only a short period of time, depending on weather conditions, especially snowfall. Much of the time, discernible tracks and trails represent only a few days' activity and only reflect the weather and travel conditions for that particular period. Deer activity for short periods may be very atypical. If a given wintering area was delineated to represent where the bulk of the deer activity was observed the chances are that each time a field survey was made a different territory would be mapped. In cases of repeated surveys, it would often be difficult to decide which definition to accept. Aerial surveys, whether by fixed-wing aircraft or helicopter, introduce additional variables that place further limitations on survey work. During some winters there are very few days when the right combination of favorable flying conditions and observable patterns of deer activity exist. A further disadvantage is that after the snow melts the evidence used for mapping purposes no longer exists.

As a result of the need for accelerating mapping efforts and the frustrations involved in waiting for the right conditions, other bases for mapping have been considered. In Vermont during the early 1970's, greater reliance was placed on evidence of deer browsing (Dickinson, 1974, 1975, 1976). In doing this, the primary consideration was not to assess the effect of the deer population on its food supply in terms of whether or not it was overbrowsed, but rather to use evidence of browsing as an index of deer occupancy. The objective was to determine the portion of a wintering area, the reduction of which by diversion to other land uses would lower the capacity of the entire range unit involved to support deer. Irrespective of food, deer in the Northeast return to the same wintering grounds year after year because in one way or another these areas afford shelter from deep snow, cold and wind. The portions where the deer congregate when these conditions are most severe, even though they may be badly overbrowsed, constitute

the indispensible minimum and may be termed critical. Evidence of browsing that represents use over a period of years can serve to identify these critical portions.

The advantages of such a technique are numerous. Standardized procedures are easy to develop, allowing for more consistency. Not only is the current winter's use apparent, but at times it is possible to discern winter deer use for the previous eight or more years. Whereas data derived from deer seen and tracks recorded represent occurrence for only a short period, data for degrees of browsing reflect the accumulative effect during a particular winter and the critical portions of a wintering area can be more easily identified. It can be assumed that when a deer population is at or above the carrying capacity of its winter range, the degree of browse use will be high in the critical portions. Sections where the browse is under-used can be considered to be not critical, since more food is present than the deer can use when travel conditions allow them access to it. Mapping of winter range can be done at any time of the year. Snow is not a prerequisite, nor do deer have to be encountered. Since the evidence persists throughout the year, field trips into an area to demonstrate the procedures employed can be conducted at any time. Browsed trees and shrubs, especially those exhibiting use over eight or more years, provide very suitable evidence for hearings and similar purposes.

Procedures used in Vermont involved going into a wintering area and, working toward the center, starting to map the critical portions when a certain degree of browsing was encountered. The entire perimeter would be cruised, with jogs being made toward and away from the center to determine as precisely as possible where the degree of browsing changed. In order to qualify as a critical part of the wintering area, evidence of moderate or heavier deer browsing for at least the three previous winters had to be noted. Portions less heavily browsed could be considered part of the wintering area, but for these purposes were not deemed critical. At the time, deer populations over much of Vermont were above the carrying capacity of the winter range (Dickinson and Garland, 1974).

To standardize procedures as much as possible, the following terms for describing the degree of deer browsing were defined. Browse preferences were based on data from field studies in New York (Severinghaus, 1974).

Negligible	Practically no evidence of past winter deer browsing, although there may be some scattered nipping of a few buds, but certainly nothing that would in any way retard plant growth.
Light	Browsing on preferred species such as apple *(Malus pumila)*, striped maple *(Acer pennsylvanicum)*, sumac *(Rhus typhina)*, red maple *(Acer rubrum)*, witchhobble *(Viburnum alnifolium)* and hemlock *(Tsuga canadensis)*, but nowhere heavy enough to keep these plants from growing out of reach. Negligible browsing on the poorest species such as witch hazel *(Hamamelis virginiana)*, beaked hazelnut *(Corylus cornuta)*, white pine *(Pinus strobus)*, white birch *(Betula papyrifera)*, hop hornbeam *(Ostrya virginiana)* and balsam fir *(Abies balsamea)*.
Moderate	Browsing on the preferred species mentioned, with a number of these plants being prevented from growing out of reach. Light or sometimes heavier browsing on second choice and readily eaten species such as red oak *(Quercus rubra)*, sugar maple *(Acer saccharum)*, white ash *(Fraxinus americana)*, yellow birch *(Betula lutea)*, hickory (*Carya* spp.), shadbush (*Amelanchier* spp.) and black cherry *(Prunus serotina)*.
Heavy	Browsing on the better browse species already mentioned, with the bulk of each year's annual growth chewed off and practically all of these plants being prevented from growing out of reach. Moderate browsing on some of the poorest species cited.
Very heavy	Virtually all of the better browse species being held down, with many dying back. Removal of portions of the stems farther back than the previous summer's growth noticeable. Heavy browsing on second choice and poorer species, with most of these being prevented from growing out of reach. Moderate, heavy or sometimes very heavy browsing on the poorest species, with even these being killed back at times.

Using these definitions, the critical portions of deer wintering areas were plotted on U.S. Geological Survey topographical maps, with notes on date of survey, name of observer, snow conditions, patterns of deer activity and degree of browsing being inserted in the margins.

Due to differences in growth characteristics and resistence to browsing, some browse species are better adapted than others to analysis of use by deer. Striped maple was the best species encountered for reading the history of a wintering area. Figure 1 shows a stem of striped maple which reveals that deer fed in the particular area for at least five winters and each year consumed some of previous summer's growth on each twig. It can be seen that, each time a terminal bud and its stem were browsed, two of the laterals took over, just as happens when a shrub is pruned. When plants are very heavily browsed they become quite difficult to read (Figure 2). Other species that are very well adapted to analysis include red maple, sugar maple and white ash. For some of the starvation or poor foods appraisals can be made quite readily. If white pine, beech *(Fagus grandifolia)* or balsam fir have been heavily used by deer over the years, the observer may be fairly sure he is in the heart of a wintering area.

Figure 1. Stem of striped maple exhibiting deer browsing for five winters, i.e.: 1 notes current winter's browsing; 2, the winter before; 3, two winters prior; etc.

The technique works best where deer populations are at or above the carrying capacity of their range. Where winter population densities are usually low, it would be more difficult to use and new criteria might be needed. Also, this technique is most applicable where the climate and other contributing factors, especially accumulations of 20 inches or more of snow, cause definite winter concentrations of deer to develop each year. In such situations, seasonal patterns of deer activity appear to be much more predictable. The nature of the country in respect to soils, topography and resultant forest types is a further consideration. Extensive flats of spruce (*Picea* spp.) and balsam fir are very poor producers of browse and, consequently, reliance on tracks, trails and direct observations of deer would have to be greater. Wintering areas situated on the more productive sites lend themselves much better to mapping by this method.

The procedure outlined facilitates improved standardization and documentation. Undoubtedly, experience will disclose desirable refinements, especially in adapting it to other areas. Where forest composition is different, the food species serving as indicators of browsing intensity may be different and require modifications in the definitions used. In some instances it may be desirable to define the degrees of browsing more precisely or to make adjustments with respect to areas that are not

Figure 2. Stem of striped maple so heavily browsed by deer that it is impossible to determine the number of years of browsing represented.

used every winter. In any case, it is felt that careful attention to the vegetation is important in developing maps of deer wintering areas.

Maps that accurately delineate critical areas are prerequisite to long-term planning and to the maintenance of winter range that is essential to perpetuating deer populations in the Northeast. The method described here affords a means of developing such maps and is believed to be applicable in New York and elsewhere in the northern range of the species.

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AN ASSESSMENT OF AERIAL PHOTOGRAPH INTERPRETATION FOR RECOGNIZING POTENTIAL BEAVER COLONY SITES[1]

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Dickinson (1971) proposed a technique for using aerial photographs to recognize potential beaver colony sites. The method considers past use by beaver as evidence of the physical capabilities of a given site to support a beaver colony. He recommended that three types of beaver habitat be recognized, i.e., flowing streams, deadwater streams and natural lakes and ponds. With respect to flowing streams, the procedure consists of working upstream and recognizing potential sites from evidence of past occupation by beaver. In order to qualify as an individual potential site, a dam site must be at least ¼ mile (in a straight line) upstream from the anticipated summer flow line of the nearest recognized colony site downstream. In areas not having a long history of beaver occupation, modifications are needed and decisions on potential sites must be made on the basis of stream gradient, vegetation and watershed characteristics. In slow-moving deadwater streams and rivers that appear to constitute suitable beaver habitat but where evidence of beaver activity would not be recognized from aerial photographs, potential sites are designated at points ½ mile apart (in a straight line). Each permanent pond or lake regardless of size is considered as one potential site. Reservoirs and other man-made bodies of water where extreme flucuations in water level may be expected are not considered as potential sites.

Studies by the authors have afforded an opportunity to evaluate Dickinson's technique. Because it appeared that trapping was holding beaver populations at a low level there, parts of the eastern and central Adirondack region were closed to beaver trapping. Following this, aerial surveys were made in which active beaver colonies were recorded, thus providing a basis of comparison with potential colony sites as derived from aerial photograph interpretation.

An area comprising 964 square miles in eastern Warren County, central Hamilton County and Fulton County was used for the comparison. The aerial censuses (complete coverage) were made periodically during the fall, and, for a beaver colony to be considered active, a fresh food bed had to be observed. All active colonies recorded by aerial observation, and all potential sites noted on the aerial photographs, were plotted on 7½- or 15-minute U.S. Geological Survey topographical maps. The locations of the active sites were then compared with those of the potential sites. Colonies observed on flowing streams were considered to occupy recognized potential sites if they were within ¼ mile downstream from the dam site at the potential site or within ¼ mile upstream of the anticipated summer flow line. Colonies observed in deadwater streams and those in ponds and lakes were considered to be on potential sites as long as the potential site was recognized by the aerial photograph interpreter.

A total of 1,361 potential sites were recognized, of which 1,005 were in flowing streams and 356 were in pond or deadwater situations. On the aerial surveys, 804 active beaver colonies were recorded, of which 589 and 215 were in the two habitat types, respectively. The data are given in Table 1. Of the total active colonies, 777 (96.6 per cent) were located on potential sites which had been recognized from aerial photographs. Also, 57.1 per cent of the potential sites were occupied by beaver.

The degree of agreement between the locations of active colonies and potential sites was lowest in southern Fulton County where beaver had been scarce or absent for many years and where, therefore, modified techniques of aerial photograph interpretation were used. Here, 94 (85.5 per cent) of the active colonies

[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-135-D.

Table 1. Relationship of Potential Beaver Colony Sites As Interpreted From Aerial Photographs to Active Colonies As Observed on Aerial Surveys

Item	Eastern Warren County	Central Hamilton County	Fulton County		Total
			Northern	Southern	
Flowing streams					
Number of potential sites	158	531	199	117	1,005
Number of active colonies	80	307	120	82	589
Active colonies on potential sites					
Number	74	307	115	68	564
Per cent	92.5	100.0	95.8	82.9	95.8
Percentage of potential sites occupied	46.8	57.8	57.8	58.1	56.1
Deadwaters, lakes and ponds					
Number of potential sites	112	103	93	48	356
Number of active colonies	39	73	75	28	215
Active colonies on potential sites					
Number	39	73	75	26	213
Per cent	100.0	100.0	100.0	92.9	99.1
Percentage of potential sites occupied	34.8	70.9	80.6	54.2	59.8
Total					
Number of potential sites	270	634	292	165	1,361
Number of active colonies	119	380	195	110	804
Active colonies on potential sites					
Number	113	380	190	94	777
Per cent	95.0	100.0	97.4	85.5	96.6
Percentage of potential sites occupied	41.9	59.9	65.1	57.0	57.1

recorded were located on potential sites, while 57.0 per cent of the recognized potential sites were occupied. The proportion of potential sites occupied was less in flowing-stream situations than in ponds and deadwaters.

In areas where beaver had been present for a much longer period, the reliability of using aerial photographs for locating potential colony sites was high. In central Hamilton County all of the active colonies were found to be on recognized potential sites, and in eastern Warren County as a whole it was over 95 per cent.

Another aspect of photograph interpretation concerns the permanence of colony sites. Johnson (1927) reported the locations of beaver dams and active colonies in 1921 in the Loon Brook drainage and the drainage of the upper Rock River (now Lake Durant) which are within the part of central Hamilton County included in this study. Although his map is not detailed enough for precise analysis, rough comparisons can be made. Johnson reported locations of dams which were interpreted by the authors to indicate 11 potential sites, assuming that a series of dams was one site. In each case the aerial photographs indicated a potential site in what appeared to be the same location. Eight of these potential sites were recorded as supporting active colonies at one time or another during the fall aerial surveys between 1969 and 1975. This demonstrates that after more than 50 years these sites still produced beaver. The aerial photographs also showed a total of 28 potential sites in these drainages, which reflects the fact that at the time Johnson did his work beaver were just becoming established after an absence of half a century and that since then they have increased substantially.

The information collected by aerial census represented a relatively short time span. The central Hamilton County area furnished the most information with six aerial surveys being made in an 8-year period. During this time, 59.9 per cent of the potential sites, as recognized from aerial photographs, were occupied when at least one census was made. During the same period, the number of active colonies

rose from a low of 67 in 1968 to a high of 169 in 1973, or an increase of 152 per cent, yet all of the added colonies occupied previously recognized sites. The aerial photographs used for this area had been taken in 1968, and thus the validity of the technique is supported by the fact that the potential sites were interpreted from photographs taken at a time when the beaver population was relatively low.

In southern Fulton County, where the current beaver occupancy is of relatively recent origin, the recognition of potential colony sites from aerial photographs gave satisfactory results. In this area, too, the photographs had been taken in 1968, and after that the number of active colonies increased greatly, associated with suspension of beaver trapping in 1969. Yet aerial surveys showed that 85.5 per cent of the colonies observed were on potential sites as recognized from photograph interpretation.

The data collected in this study confirm that the recognition of potential beaver colony sites by using aerial photographs is a reliable and accurate technique. Coupled with information on the physiography of an area, knowledge of the number and distribution of the potential colony sites on it augments the wildlife manager's ability to evaluate its capacity for supporting beaver populations.

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LONG SMALL INTESTINES IN THE OSPREY AND PEREGRINE FALCON[1]

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During the course of doing necropsies on birds of prey, it was observed that ospreys *(Pandion haliateus)* seemed to have very long small intestines. To verify this observation, measurements of the alimentary canals of seven ospreys were compared with those of 10 red-tailed hawks *(Buteo jamaicensis)*, two peregrine falcons *(Falco peregrinus)* and five great horned owls *(Bubo virginianus)*.

For each specimen, the entrails were removed and the mesenteries cut, and then the alimentary canal was laid out straight, but without stretching, and measured with a meter stick. The measurements taken were: (1) proventriculus-gizzard, i.e., from the anterior edge of the proventriculus to the posterior end of the gizzard; (2) small intestine, i.e., from the posterior end of the gizzard to the junction of the cecae; (3) large intestine, i.e., from the junction of the cecae to the end of the cloaca. The data are summarized in Table 1.

The lengths of the proventriculus-gizzard segment were similar for all the species examined, and no remarkable differences in length were noted for the large intestine. However, with respect to the small intestine, the average for the ospreys (287.9 centimeters) was about three times that for the red-tailed hawks (97.0 centimeters), peregrine falcons (97.0 centimeters) and great horned owls (94.1 centimeters). When the length of the small intestine was adjusted for the size of the bird, it was found that the ospreys averaged approximately 20 centimeters of small intestine per 100 grams of gross weight, the peregrine falcons 16.9 centimeters, the red-tailed hawks 7.9 centimeters and the great horned owls 7.0 centimeters. In proportion to their body weights, both the osprey and peregrine falcon had long small intestines. Figure 1 compares the tract of an osprey with that of a red-tailed hawk, and the much greater length and smaller diameter of the osprey's small intestine is evident.

The diameter of the small intestine (mid ileum) was measured with vernier calipers and ranged from 1.4 to 3.0 millimeters for the osprey and peregrine falcon, which was about half that for the red-tailed hawk and great horned owl. The long small intestine of the osprey and peregrine falcon was surprising in view of some general statements in the literature. Wallace (1955) and Sturkie (1966) stated that herbivorous and omnivorous species of birds usually have longer small intestines than carnivorous species. However, the present data indicate that the primarily fish-eating osprey has a longer small intestine than the approximately five times heavier (7,325 grams) and mainly herbivorous wild turkey *(Meleagris gallopavo)* in which, according to Leopold (1953), the small intestine averages 224 centimeters long. Also, the small intestine of the osprey is about three times longer than that of the slightly smaller ring-necked pheasant *(Phasianus colchicus)* which is primarily a granivorous species. Similarly, the peregrine falcon preys almost exclusively on birds, but it has a longer small intestine than the comparably sized and largely herbivorous ruffed grouse *(Bonasa umbellus)* which, acording to Bump et al. (1947), has a small intestine averaging 79.3 centimeters long.

[1] The peregrine falcons and five of the ospreys were obtained through the cooperation of the Endangered Species Unit of the New York State Department of Environmental Conservation. The author also wishes to thank John Goerg for taking the photograph.

Table 1. Data on Alimentary Tract Measurements and Body Weights For Certain Birds of Prey

Species	Number of specimens		Alimentary tract measurement (centimeters)*			Gross weight (grams)	Length-weight ratios§
	Male	Female	Proventriculus -gizzard	Small intestine	Large intestine		
Osprey	3	4	7.6 (6.5 - 9.0)	287.9 (228.5 - 377.0)	8.3 (3.5 - 14.0)	1,443 (952 - 1,740)	20.0
Peregrine falcon	1	1	6.0 (5.5 - 6.5)	97.0 (91.0 - 103.0)	4.0 (3.5 - 4.5)	574 (519 - 629)	16.9
Red-tailed hawk	5	5	7.5 (6.0 - 9.0)	97.0 (80.0 - 130.0)	9.8 (5.0 - 14.5)	1,222 (850 - 1,460)	7.9
Great horned owl	3	2	8.8 (8.5 - 9.5)	94.1 (89.5 - 97.5)	11.0 (10.5 - 12.0)	1,354 (1,280 - 1,410)	7.0

* Figures in parentheses represent range of values.
§ Centimeters of small intestine per 100 grams of gross body weight.

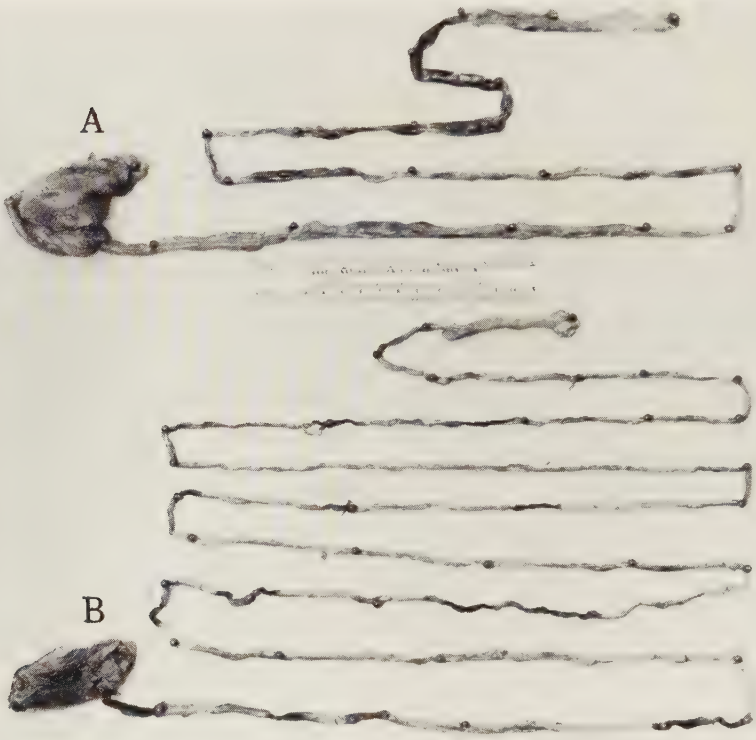

Figure 1. The alimentary canal of an osprey (A) compared with that of a red-tailed hawk (B), from the proventriculus to the cloaca. The nodular objects along the tracts were round-headed pins used to keep them in place.

Welty (1975) wrote that fish-eating birds have relatively long, thin-walled, small-diameter small intestines. Mitchell (1901) stated that, for the small intestine of piscivorous birds, "the small calibre and thick wall are doubtless a protection against injury by sharp bones" and that, in the osprey, "the gut is enormously long, and is of very narrow calibre, a modification obviously in association with piscivorous habit". Mitchell gave no measurements, but he did provide an excellent diagram of the intestinal morphology of the osprey. The long small intestine of the peregrine falcon is quite probably related to its specialized feeding.

It is curious that the osprey and peregrine falcon, both of which have long narow small intestines, have been severely affected by toxicities resulting from chlorinated hydrocarbon pesticides. Both prey on species that are likely to have bioaccumulated significant quantities of toxicants, but it may also be that, because of their long small-diameter small intestines, absorption of toxic substances is more efifcient than it is in species without their intestinal attributes. In order to explore this possibility, thorough studies on villi morphology and density, the surface area of the small intestine, passage time of food and absorption of given

quantities of chlorinated hydrocarbons would have to be carried out. Nevertheless, the long small intestines, particularly in the osprey, are an interesting anatomical fact.

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A THREE-HORNED BUCK FROM CHAUTAUQUA COUNTY[1]

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During the 1976 deer hunting season, Alan Burlett of Darien Center took a 9-point buck in the Town of Pomfret in Chautauqua County (N.Y.). The ninth point consisted of a prong protruding from the forehead just at the inner edge of the right orbit. Through the kindness of Frederick Namlik of the Adventure Taxi-

[1] The author is grateful to Paul M. Kelsey of the Department of Environmental Conservation at Cortland for bringing this unusual specimen to his attention, and to Frederick Namlik for continued assistance in examination of the skull. The specimen will be retained by its owner, Mr. Burlett.

Skull of three-horned buck from Chautauqua County (N.Y.) showing the extra horn protruding from the forehead at the inner edge of the right orbit.

dermy Studio in Hamburg, the author was able to examine, measure and photograph this anomalous skull.

The supernumerary horn arises from the extreme anterior end of the frontal bone and has no connection with the base of the regular antlers. It measures 123 millimeters in length and 23 millimeters in diameter at the base. The pedicel is not entirely normal, and it is not clear whether or not the horn would have been deciduous. If not, the animal would have borne a remarkable resemblance to the mythical unicorn after its normal antlers had been shed.

While extra prongs are not extremely rare in white-tailed deer *(Odocoileus virginianus)*, they are usually attached to the pedicel of one of the antlers and simply run under the skin for a short distance before emerging. This horn is remarkable in being quite separate and distinct in its origin from the normal antlers.

NOTES ON WINTER MORTALITY IN WILD TURKEYS

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The wild turkey *(Meleagris gallopavo)* is considered a hardy native species that readily tolerates most New York winters. However, from late January through March in 1977, nine juvenile wild turkeys that had been found dead were submitted to the wildlife pathology unit for necropsy. During this period upstate New York experienced extreme cold with deep snow blanketing an abundant mast crop. The dates and locations where these birds were found, together with the age, sex and gross weight of each, are given in Table 1.

Table 1. Juvenile Wild Turkeys Found Dead and Submitted to the Wildlife Pathology Unit, January-March, 1977.

Specimen No.	Date found	Sex	Location		Gross weight (grams)
			Town	County	
1	January 28	Male	Hancock	Delaware	3,279
2	January 29	Male	Rockland	Sullivan	2,975
3	February 1	Female	Cherry Valley	Otsego	1,898
4	February 1	Male	Colchester	Delaware	3,447
5	February 1	Female	Callicoon	Sullivan	1,869
6	February 8	Female	Colchester	Delaware	1,704
7	February 10	Female	Dryden	Tompkins	1,750
8	February 17	Female	Delhi	Delaware	1,820
9	March 30	Female	Orwell	Oswego	1,870

Specimen No. 1, a juvenile male found dead in the Town of Hancock in Delaware County on January 28, 1977, was an unusual case. At necropsy, the bird was found to be emaciated (gross weight, 3,279 grams). The mid-portion of the esophagus was greatly distended by a mass of fertile heads from sensitive fern *(Onoclea sensibilis)* which were blocked by three adhering heads of great burdock *(Arctium lappa)* with numerous bracts firmly imbedded in the esophageal mucosa. The esophagus was very hyperemic in the area of blockage, and the alimentary canal beyond the obstruction was empty except for 10 small pebbles in the gizzard. There were no supplies of subcutaneous or thoraco-abdominal cavity fat, and the sternal musculature was atrophic. The liver was atrophied and sharp-edged. One shotgun pellet (No. 6) was encapsulated in the subcutaneous tissues overlying the sternal musculature, but this was an old wound and no other gross pathology could be attributed to lead pellets.

During the winter, when mast and other foods are covered by snow, burdock has been reported to be an important food of wild turkeys in southwestern New York (Eaton et al., 1970). Burdock seeds, bracts and fibers were common findings in the turkey droppings they examined. In the present case, however, the ingestion of burdock heads had contributed to the starvation and death of the bird by blocking the esophagus for the passage of food.

The other eight juvenile turkeys, two males and six females, were all in extremely poor flesh. The mean gross weight of the males was 3,211 grams (7.1 pounds), and that of the females was 1,819 grams (4 pounds). For turkeys shot in the fall in Pennsylvania (Bowers, 1958), the mean weight of 36 juvenile males was 10.06 pounds (4,567 grams), and that of 36 juvenile females was 7.25 pounds (3,292 grams). However, by January-March juveniles would be expected to have higher

body weights than those for the fall-shot birds reported by Bowers. For the specimens reported here, the males had lost at least 30 per cent of their body weight, and the females about 45 per cent. Gerstell (1942) reported similar findings for a juvenile male and juvenile female wild turkey held, in an unsheltered outdoor pen, without food in Pennsylvania during March. The birds died of starvation in 10 and 20 days, respectively. The male fell from an initial gross weight of 11.21 pounds to 7.12 pounds at death (a 36.5 per cent loss of body weight), while the female dropped from 9.45 pounds to 4.81 pounds (a loss of 49.1 per cent).

On postmortem examination it was found that the eight turkeys reported here had exhausted their supplies of subcutaneous and thoraco-abdominal cavity fat. The sternal and leg musculatures were extremely atrophic, indicating extensive catabolism of muscle proteins. The livers and kidneys were atrophic. The crops were empty except for specimens No. 2 and No. 5 in which a few hemlock and pine needles were found, respectively. None of the turkeys showed heavy loads of parasites or other pathological conditions that could have contributed to their emaciated state. The death of these birds was attributed to starvation.

Further evidence of starvation in juvenile wild turkeys comes from observations made at the Wildlife Resources Center at Delmar (N.Y.) on a live juvenile male that had been captured by hand in a weakened, emaciated condition (8 pounds or 3,632 grams) on February 21, 1971 in the Town of Ellicottville in Cattaraugus County (N.Y.). This turkey had, 5 months before on September 22, 1971, been trapped and banded in the same vicinity and then weighed 8.4 pounds (3,814 grams). The debilitated bird weighed 0.4 pound less at approximately 9 months of age than it did when banded at about 4 months. Its plumage was in good condition, but little musculature was present on the sternum. X-rays did not reveal any birdshot or fractures. Giemsa-stained blood smears were negative for blood parasites Examinations of fecal material for parasites were negative, and cultures of fecal material were negative for pathogenic bacteria.

The turkey was kept isolated in a small shed, and it appeared remarkably tame as it initially pecked cracked corn from the hand. It was fed, *ad libitum*, cracked corn and non-medicated gamebird pellets, and as it gained strength it also gained in wildness. Two months later it weighed 10.5 pounds (a 30.1 per cent weight gain) and no longer showed tame behavior. The bird that had fed from the hand now attempted to fly through the poultry netting in the shed window whenever anyone entered the building. The healthy turkey was released to the wild.

All the birds described in this note were juveniles. Because of their smaller size, position in the social structure and possibly lack of experience, they would be expected to be more susceptible than adults to starvation during severe winter weather. During unusually severe winters in New York, coupled with a poor production of mast and other wild foods, significant losses of juvenile and some adult wild turkeys from starvation may be expected.

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